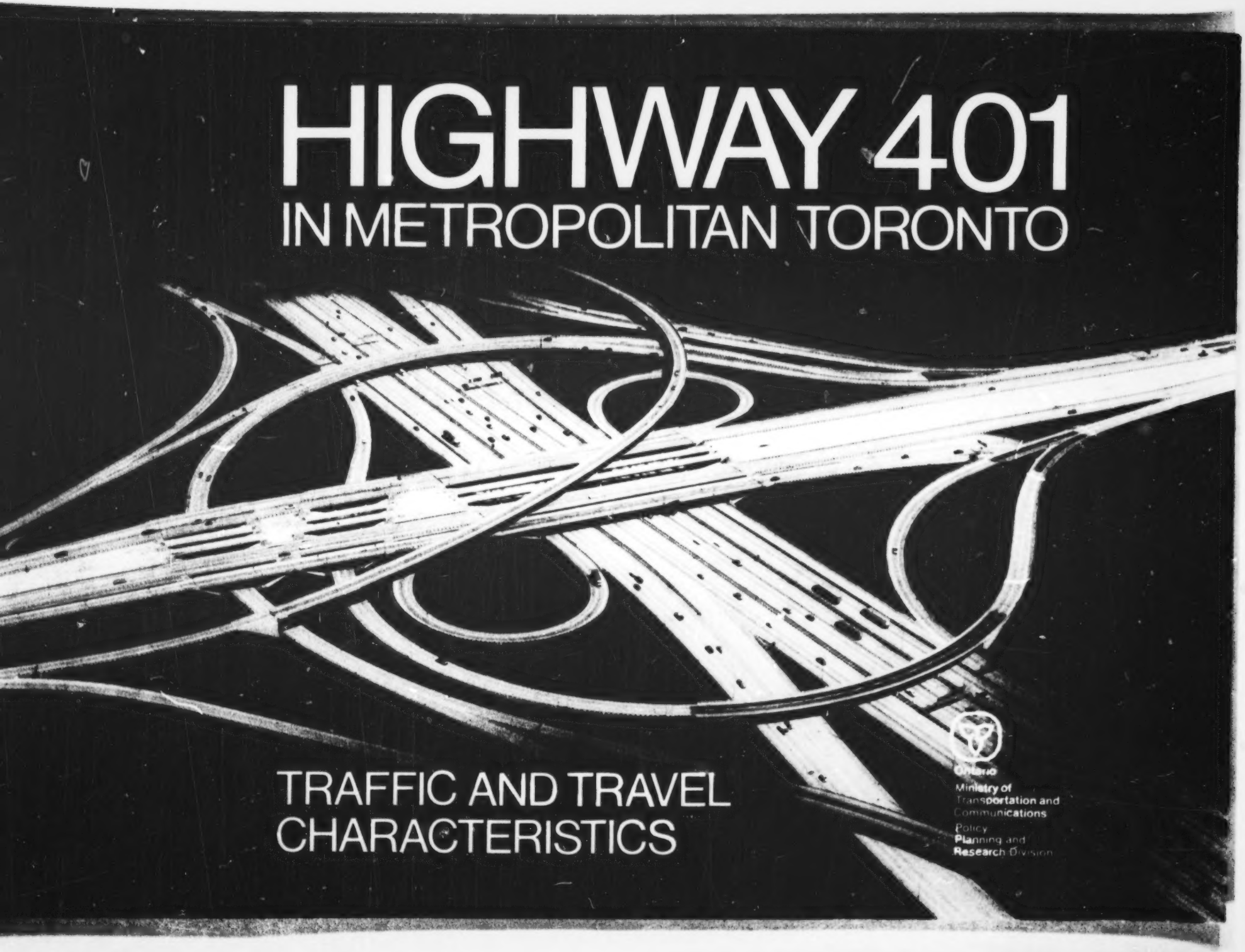
HIGHWAY 401
IN METROPOLITAN TORONTO



TRAFFIC AND TRAVEL CHARACTERISTICS

Ontario
Ministry of
Transportation and
Communications
Policy
Planning and
Research Division

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Transportation Planner
Transportation Demand Forecasting Office
Policy Planning Branch

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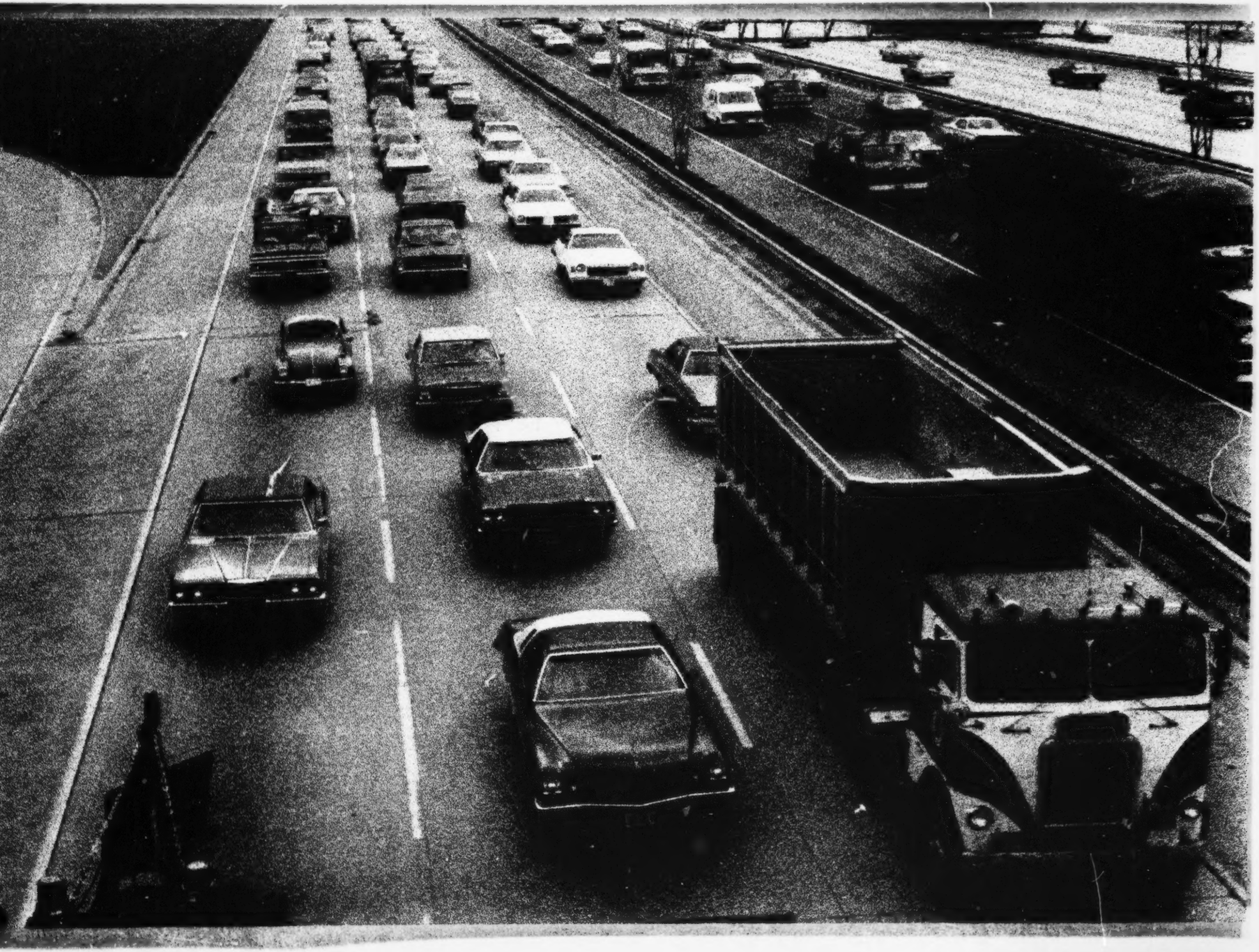
1 Introduction

The portion of the Macdonald-Cartier Freeway (known as Highway 401*) that runs along the northern outskirts of the City of Toronto was originally conceived as the Toronto Bypass. It was designed to provide an eastwest route for through traffic without entering the municipality. With the rapid growth of Metropolitan Toronto and its adjacent municipalities, Highway 401 no longer serves primarily as the Toronto Bypass but has now become a major urban artery within Metropolitan Toronto. In fact, before Highway 401 was completed in 1958, the traffic volume had increased so tremendously that a major expansion became necessary. Over the next two decades Highway 401, in providing a route for moving great numbers of people and goods, also stimulated the residential and industrial development along that corridor. By 1980, it had become one of the busiest highways in North America, carrying an average daily traffic of about 233 800 vehicles (between Dufferin and Keele Streets). The highest daily volume — 299 040 vehicles — was recorded on Friday October 10, 1980. Over a 12-hour period (07:00 to 19:00), about 24% of the traffic crossing Metropolitan Toronto's western boundary was on Highway 401, as was 78% of cross-boundary traffic in the east.

Information on Highway 401's traffic volumes has been collected on a continuous basis at the Permanent Counting Station (P.C.S.) at Keele Street and by other periodic traffic counting activities.

The Ministry of Transportation and Communications conducted travel surveys between 1977 and 1979 at four locations on the highway to obtain data on the travel characteristics of Highway 401 users. Licence plates of automobiles passing the survey stations were photographed and survey questionnaires were sent to their registered owners. This booklet is intended to provide some insights into the traffic and travel characteristics of Highway 401 within Metro Toronto based on information obtained from those surveys and traffic counts. It is not an in-depth analysis of the highway system but an attempt to highlight some of the interesting characteristics evident from the data.

*As the title of this booklet indicates, "Highway 401" as discussed herein means the Toronto portion of the Macdonald-Cartier Freeway between Highway 2 on the east and Highway 427 on the west.

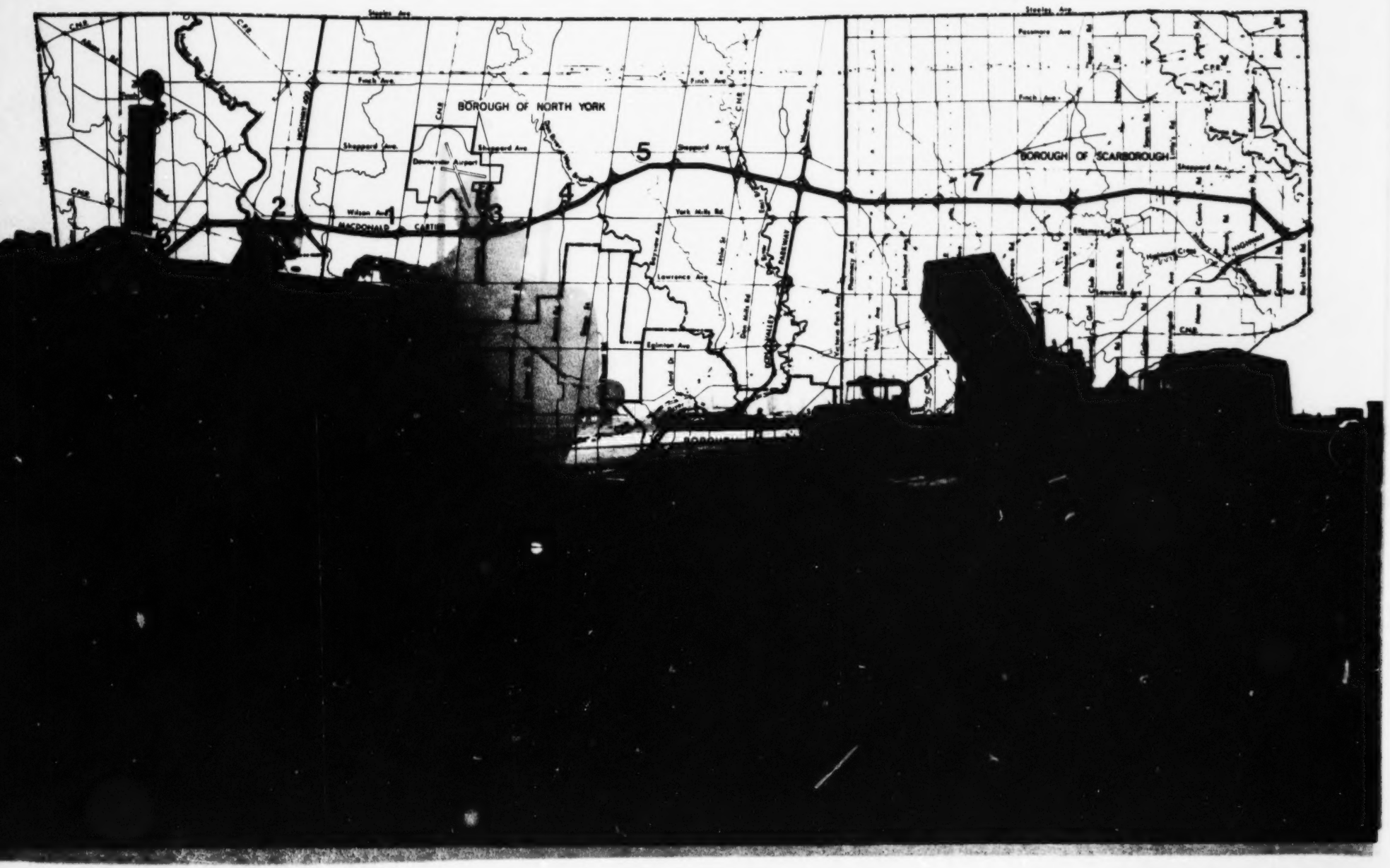


2 Historical Development

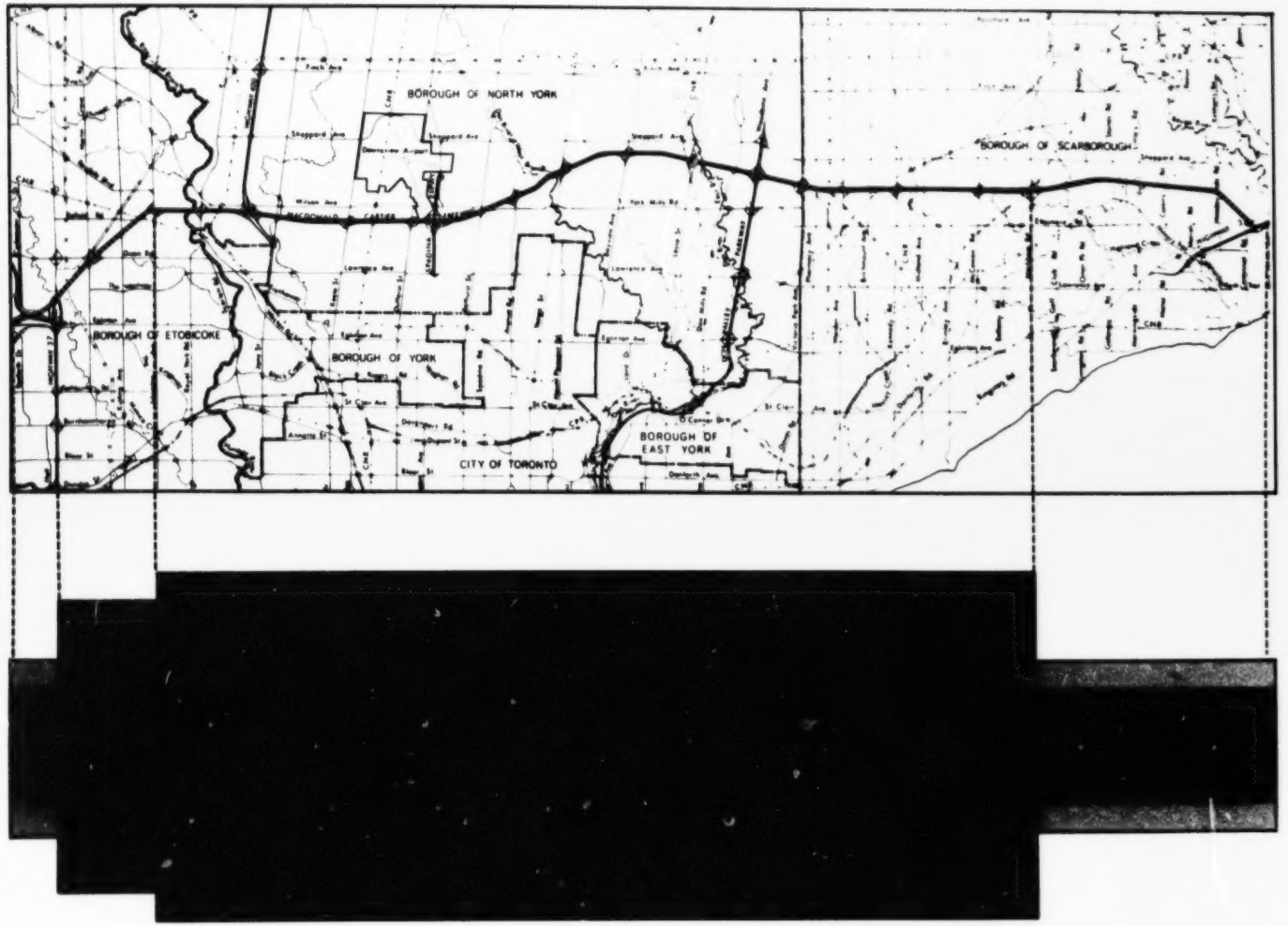
Highway 401 was built and opened to traffic in various stages. Construction began in 1952, and by the end of 1958, the basic four-lane divided, controlled access highway was completed. But unprecedented growth of the Metropolitan area meant that the volume of traffic on the highway rapidly exceeded its capacity.

To keep pace with rapid traffic growth, the initial four-lane facility underwent significant changes within its first two decades. The changes included major widenings, addition and improvement of interchanges and the development of a 12-lane core/collector freeway system from Highway 48 to Islington Avenue. In 1958, the highest annual average daily traffic was about 55 000 vehicles between Yonge Street and Avenue Road. By 1980, that highest volume had reached 233 800 vehicles (between Dufferin and Keele Streets).

SECTION	KM	DATE OPENED
1 Highway 400–Dufferin St.	5	August 1952
2 Weston Rd.–Highway 400	1.4	September 1952
3 Dufferin St.–Bathurst St.	2.2	October 1952
4 Bathurst St.–Yonge St.	2.9	December 1952
5 Yonge St.–Bayview Ave.	1.9	April 1955
6 Highway 27–Weston Rd.	5.4	September 1955
7 Bayview Ave.–Highway 2	20	August 1956
8 Highway 10–Highway 27	11	November 1958


BOROUGH OF NORTH YORK
BOROUGH OF SCARBOROUGH
Steeles Ave
Finch Ave
Sheppard Ave
Wilson Ave
York Mills Rd
Lawrence Ave
Eglinton Ave
MACDONALD
CARTIER
1
2
3
4
5
7

Major Widenings
(Number of Lanes)



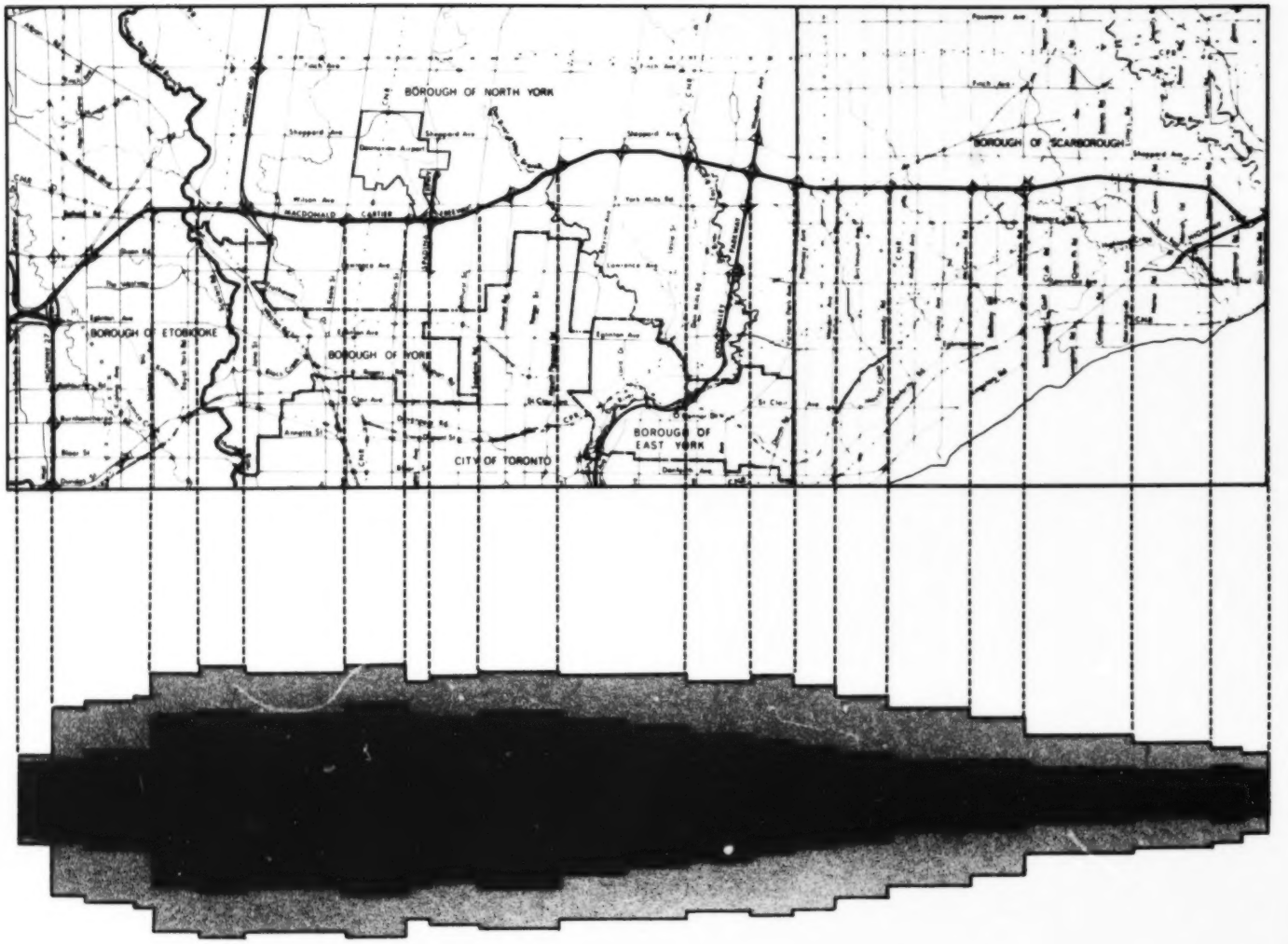
Period of Completion

1952–1958

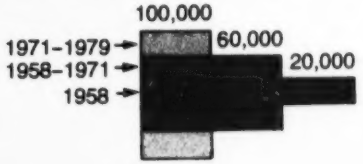
1964–1971

1973–1975

Traffic Volume on Highway 401 (Toronto)



AADT (Annual Average Daily Traffic)



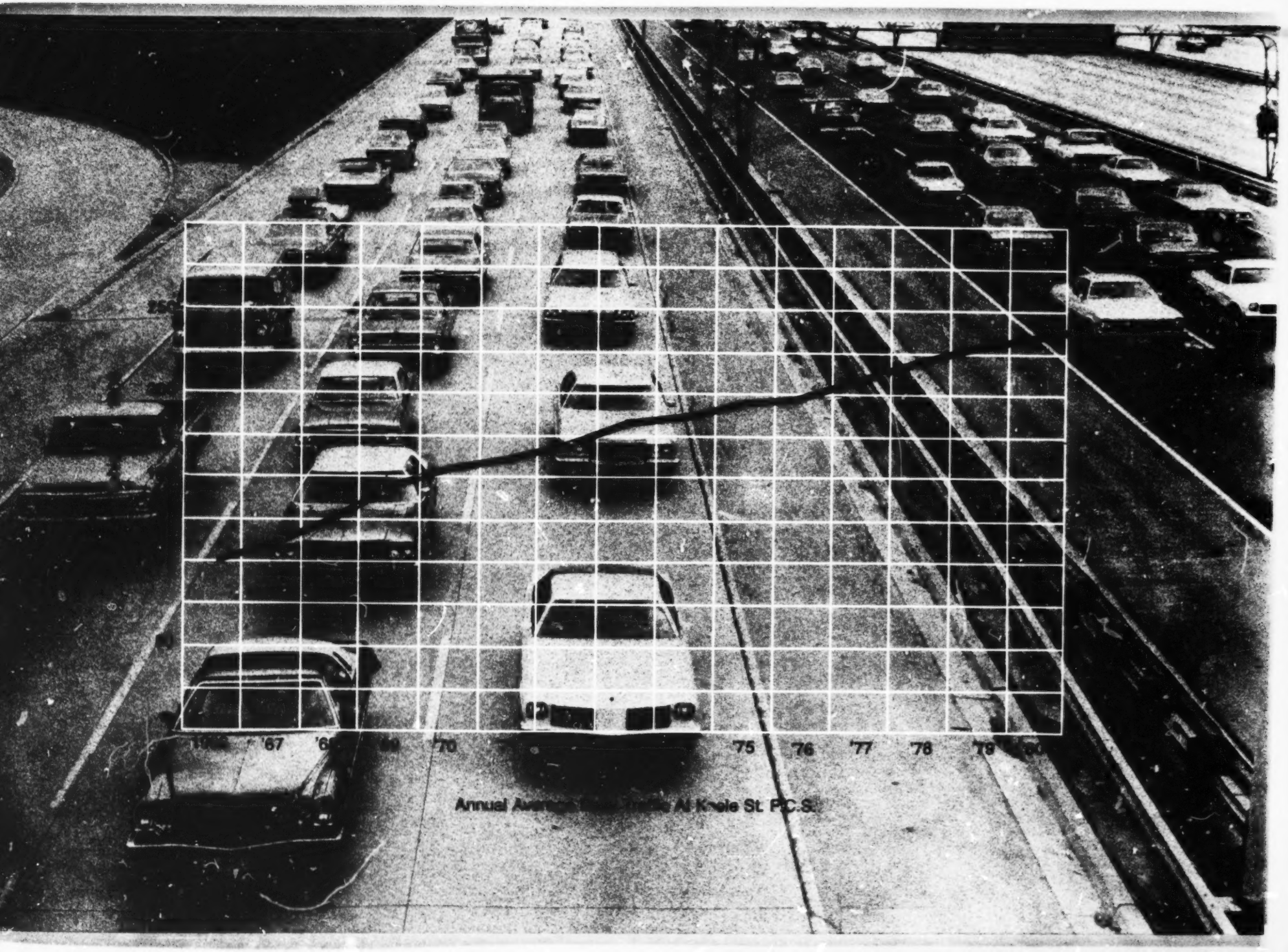
3 Traffic Characteristics

3.1/ Traffic Volume Variations

The Permanent Counting Station (P.C.S.) near Keele Street immediately north of Highway 401 has been collecting traffic volume information since 1966. It provides valuable time-series data on traffic patterns throughout the day, the week, and the year. Over the years, traffic characteristics observed at this station have been used in various traffic and transportation studies.

3.1.1/ Yearly Variation (1966-1980)

Since the installation of the Keele Street P.C.S. in 1966, the traffic volume has increased at an average annual growth rate of 10%. However, most of the rapid growth occurred before 1971. The highest increase in a single year was 15%, which occurred between 1968 and 1969. The lowest increase — 1.7% — was recorded between 1975 and 1976.

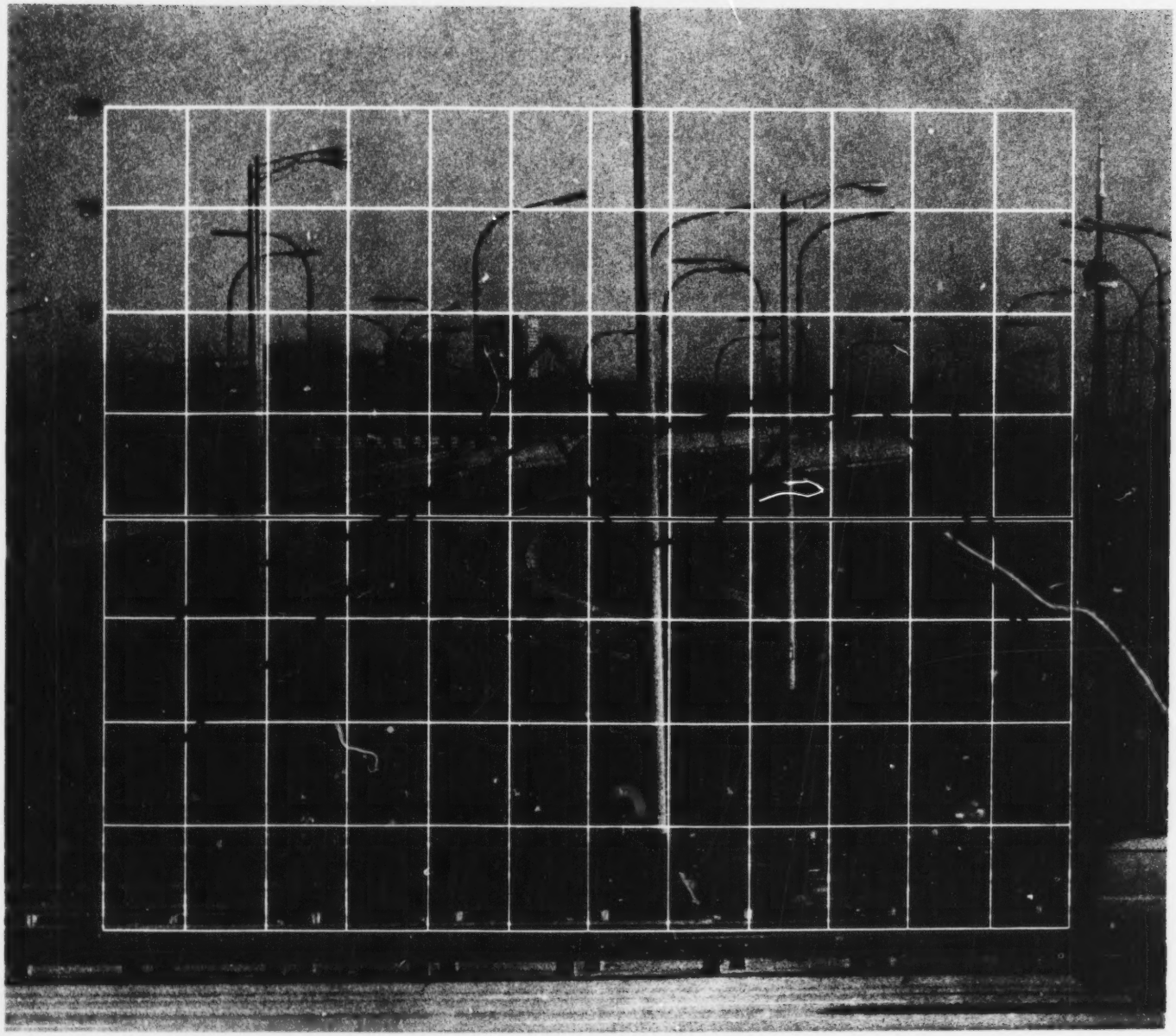

'67
'70
'75
'76
'77
'78
'79
Annual Average
At Knole St. P.C.S.

3.1.2/ Monthly Variation

Highway 401 has shown relatively little seasonal variation in its traffic volume. Keele Street data for the period between 1970 and 1980 indicate that the average daily traffic during the winter months (December to April) was about 7 to 13% below the annual average daily traffic. On the other hand, the traffic volume was 2 to 8% higher from May to November. The lowest and highest daily volume were recorded in January and June. A primary and a secondary peak in the summer months occurred in June and September, respectively.

Observations of the variations in the peak hour traffic volumes for a weekday yielded some interesting results: This peak usually occurred during 17:00. A calculation of the average traffic volumes for that hour for each month between 1970 and 1980 showed a different distribution pattern. There was less variation from the annual average than that of the daily traffic volumes. The peak hour traffic volumes in July and August fell below the average in addition to those in the winter months. There are also two peaks; the first one was in June while the second one occurred from September to November.

Monthly Variation of Traffic Volumes (1970–1980) at Keele St. P.C.S.



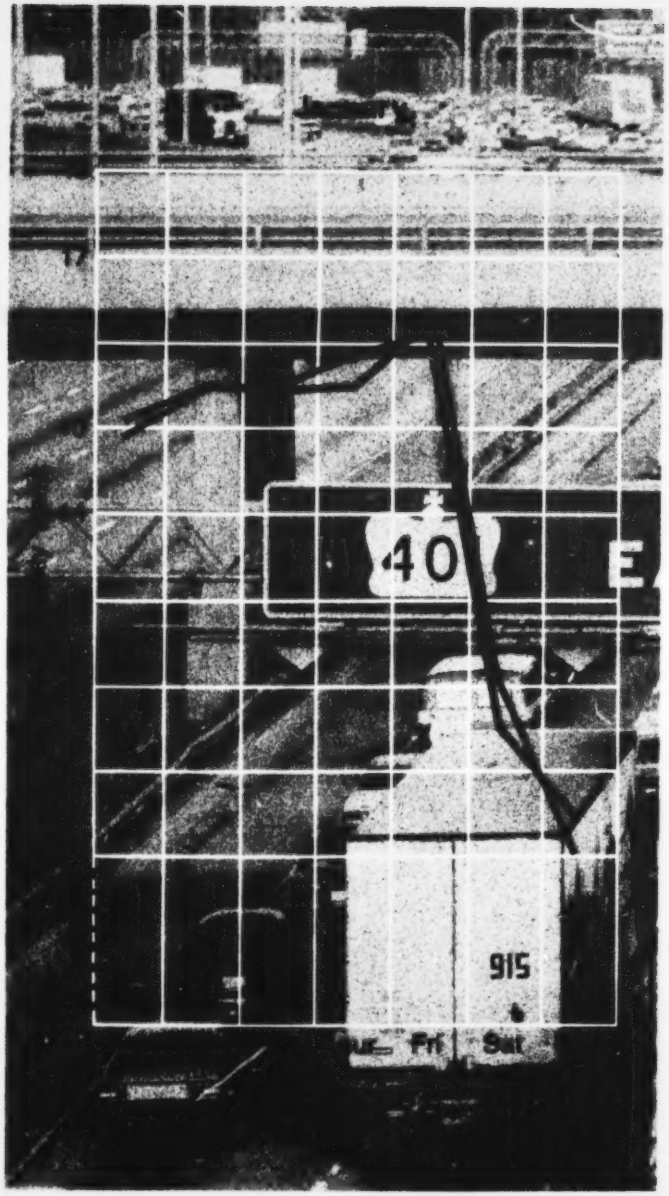
Average daily traffic

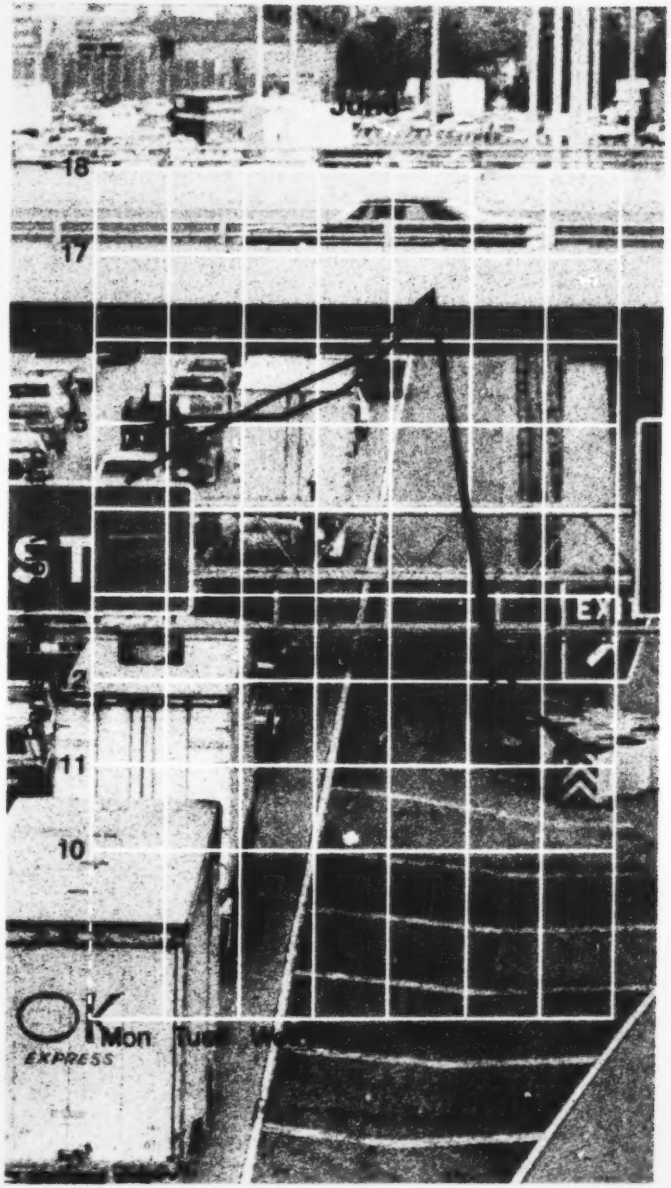
Average peak hour traffic

3.1.3/ Daily Variation

The daily variation of traffic during an average week in the months with the highest traffic volume (June) and lowest traffic volume (January) were compared. Several similarities in percentage distribution were noticeable: Friday's traffic was the highest in all cases, and lowest daily volume occurred on Sundays. Differences included a higher proportion of weekend traffic in June as compared to January. The variation in percent distribution of traffic volume for the rest of the week (Monday to Thursday) was greater in June than in January for both 1970 and 1980.

At Keele St. P.C.S.





1980

1970

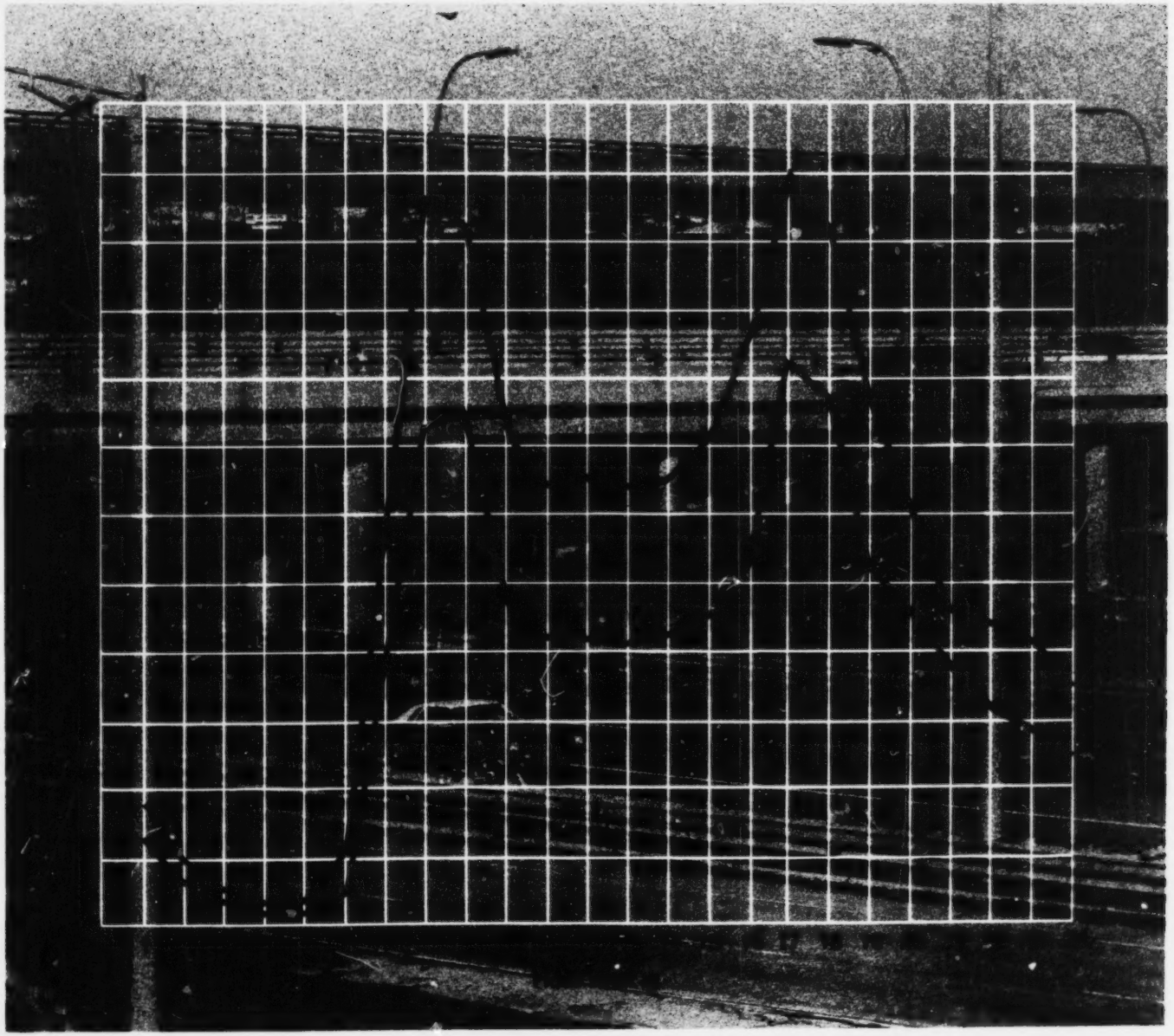
3.1.4/ Hourly Variation

Average hourly traffic volumes calculated for four Wednesdays in June of 1970 and 1980 showed very similar distribution patterns. The period from 01:00 to 05:00 had the lowest hourly volumes and the two peaks occurred between 07:00 to 09:00 and 16:00 to 18:00 with the afternoon peak higher than the one in the morning.

In both 1970 and 1980, the westbound traffic was still heavier than the eastbound volume during the morning peak period and vice versa in the afternoon peak period. However, the peak hour of the westbound traffic in the morning moved from 09:00 as recorded in 1970 to 08:00 in 1980.

Although there was a minimal increase in the number of vehicles recorded between 24:00 to 06:00, the volume of traffic at 06:00 grew by more than 90%. Such an increase might indicate an earlier start of the morning peak period. The greatest increase in traffic volume occurred during the morning and afternoon peak periods.

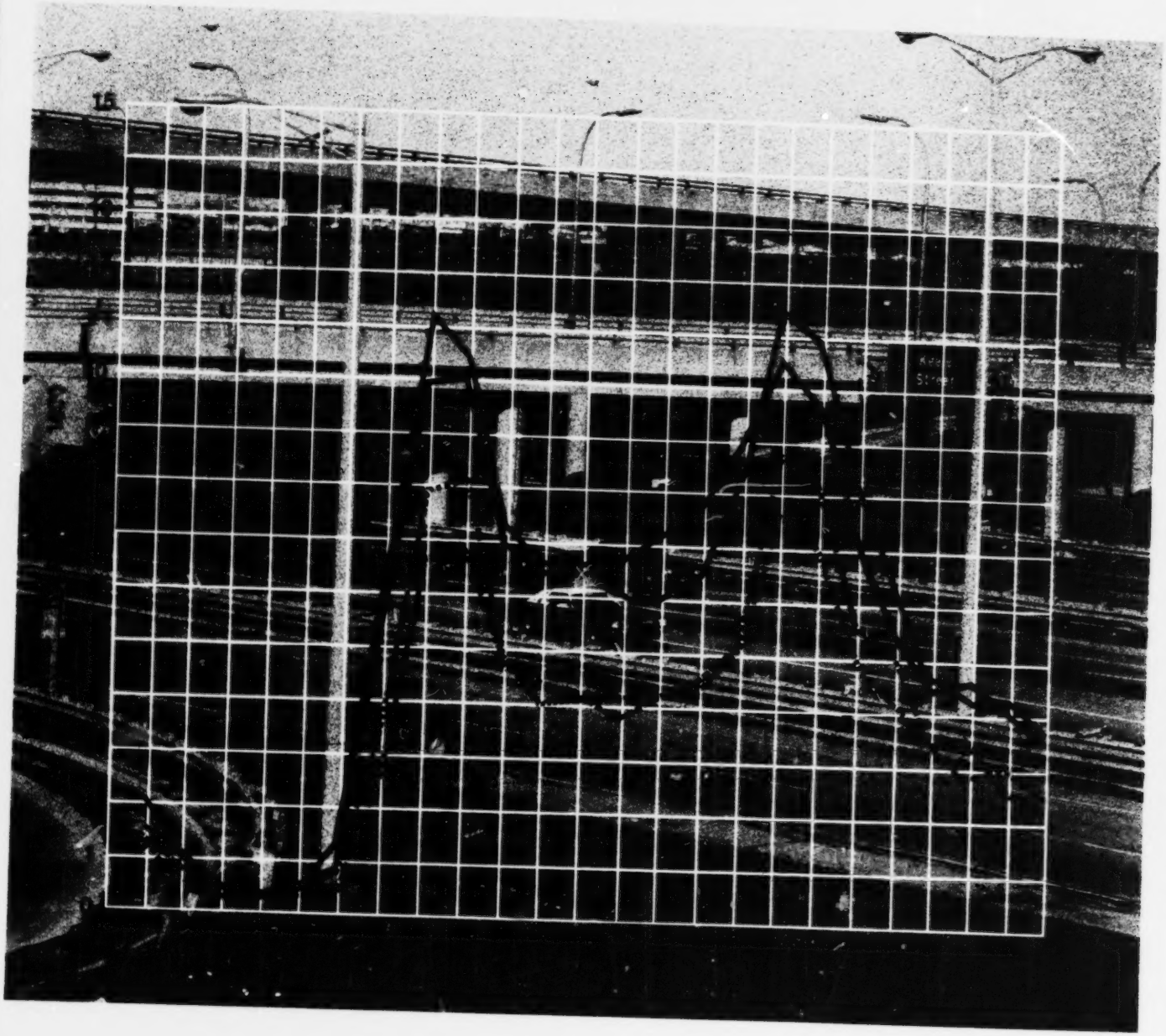
At Keele St. P.C.S.



Average of 4 Wednesdays in June 1980

Average of 4 Wednesdays in June 1970

At Keele St. P.C.S.



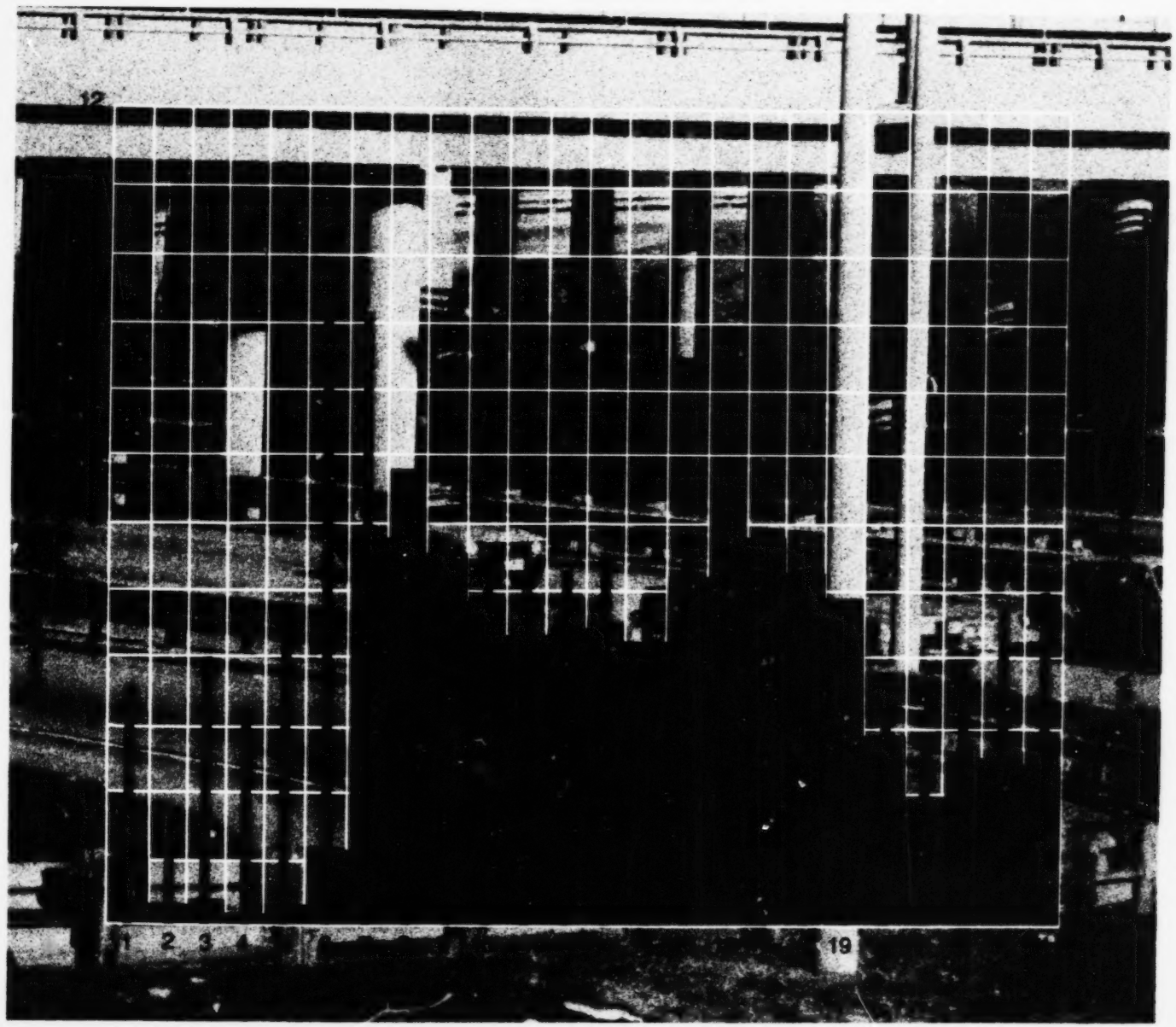
Average of 4 Wednesdays

Eastbound Westbound

▪▪▪▪▪▪▪▪ ▪▪▪▪▪▪▪▪ in June 1970

▬▬▬▬ ▬▬▬▬ in June 1980

At Keele St. P.C.S.



Increase in Traffic Volume

Percent Change in Traffic Volume

3.2/ Interchange Usages

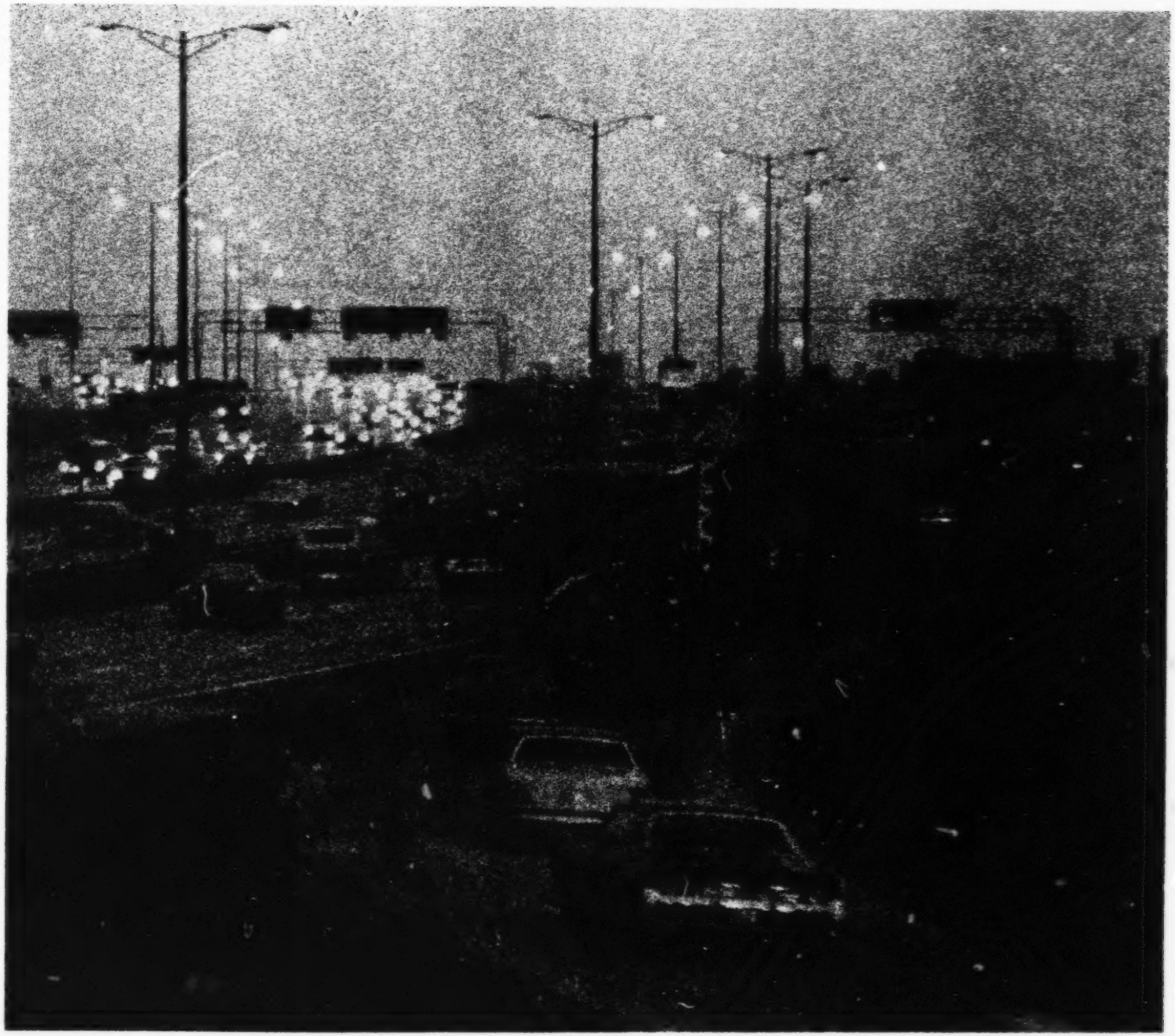
Traffic using Highway 401 entered and exited the facility through various interchanges. In 1980, an average daily traffic volume of about 1 127 000 vehicles was recorded using all the interchanges within Metro Toronto. The most heavily used interchanges were those at Highway 427, Highway 400, Allen Expressway and Don Valley Parkway/Highway 404. Together they accounted for 38% of the on and off traffic movement. From the information obtained from the four survey stations, with the exception of the Allen Expressway interchange, each of the interchanges was used by more than 20% of the auto traffic passing through each station. Since those four interchanges are connected to another freeway facility, it indicates that Highway 401 not only carried a high volume of east-west traffic but also served as a major distributor/collector of traffic from the south and north direction.

Annual Average Daily Traffic No. of Vehicles × 1000
80
70
60
50
40
30
20
10
BOROUGH OF SCARBOROUGH
BOROUGH OF NORTH YORK
BOROUGH OF EAST YORK
CITY OF TORONTO
BOROUGH OF YORK
BOROUGH OF ETOBICOKE
On
Off
Survey Stations

3.3/ Speeds and Delays

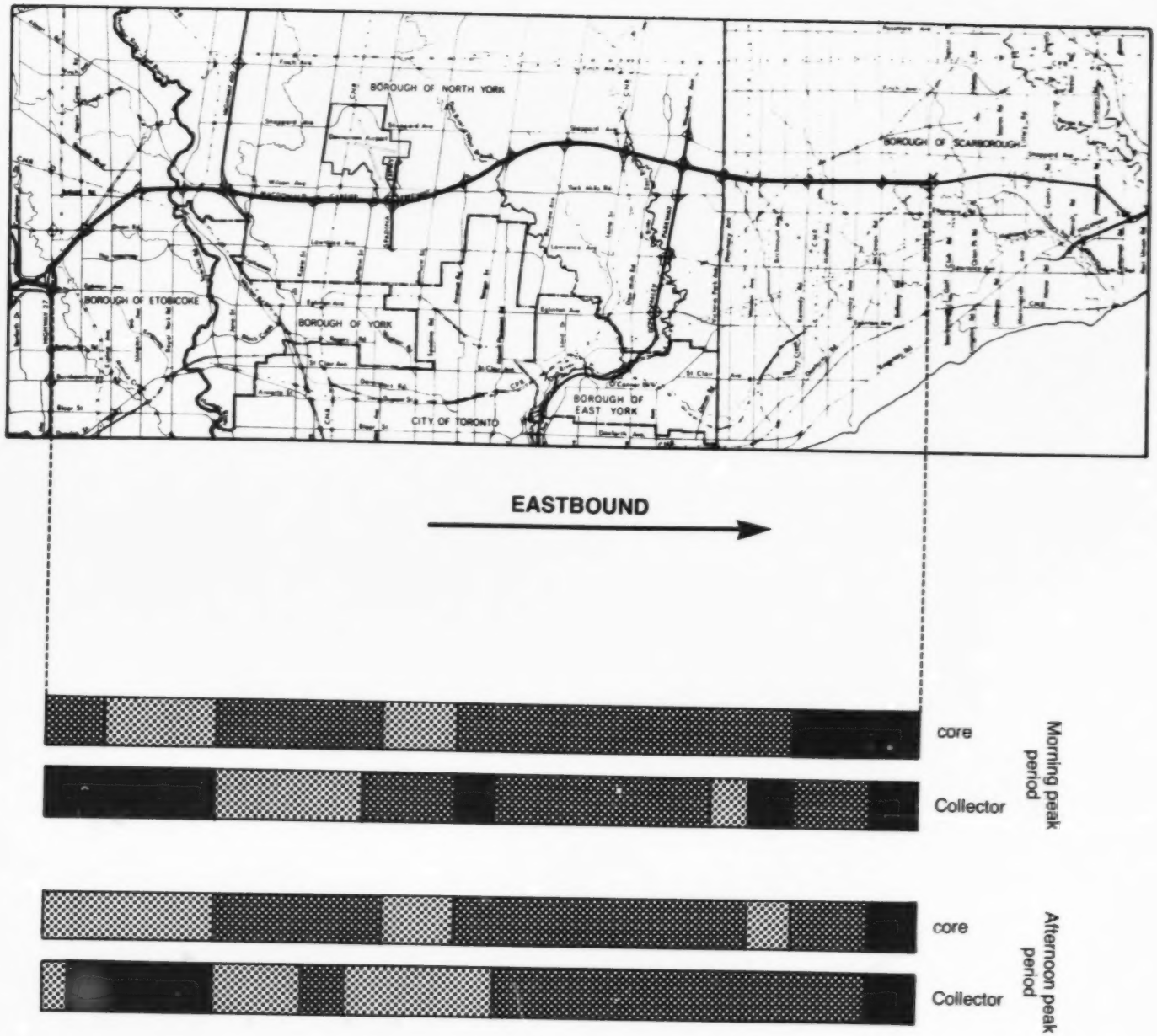
Rapid traffic growth on Highway 401 has made uninterrupted travel at high speed more difficult, especially during peak periods. A speed/delay study conducted in October 1977 identified various sections of the highway where congestion had reduced optimal operating speeds. The accompanying figures show average speeds obtained from several trips in each direction during the morning and afternoon peak periods (07:00 to 09:00, 16:00 to 18:00) between October 25 and 27, 1977. All speed reductions were caused by congestion alone; the effects of incidents such as accidents and poor weather conditions were excluded in the calculations.

In the eastbound direction, both in the morning and afternoon, the operating speeds in most sections west of Yonge Street were lower than those on the east. Westbound, the sections between Avenue Road and Don Valley Parkway and between Warden Avenue and Kennedy Road in the collector lanes were the slowest during the morning peak period. The average speeds obtained from the study for the distance between Highway 427 and Highway 48 were about 90 km/h (morning) and 77 km/h (afternoon) for eastbound traffic and about 82 km/h (morning) and 93 km/h (afternoon) for westbound.

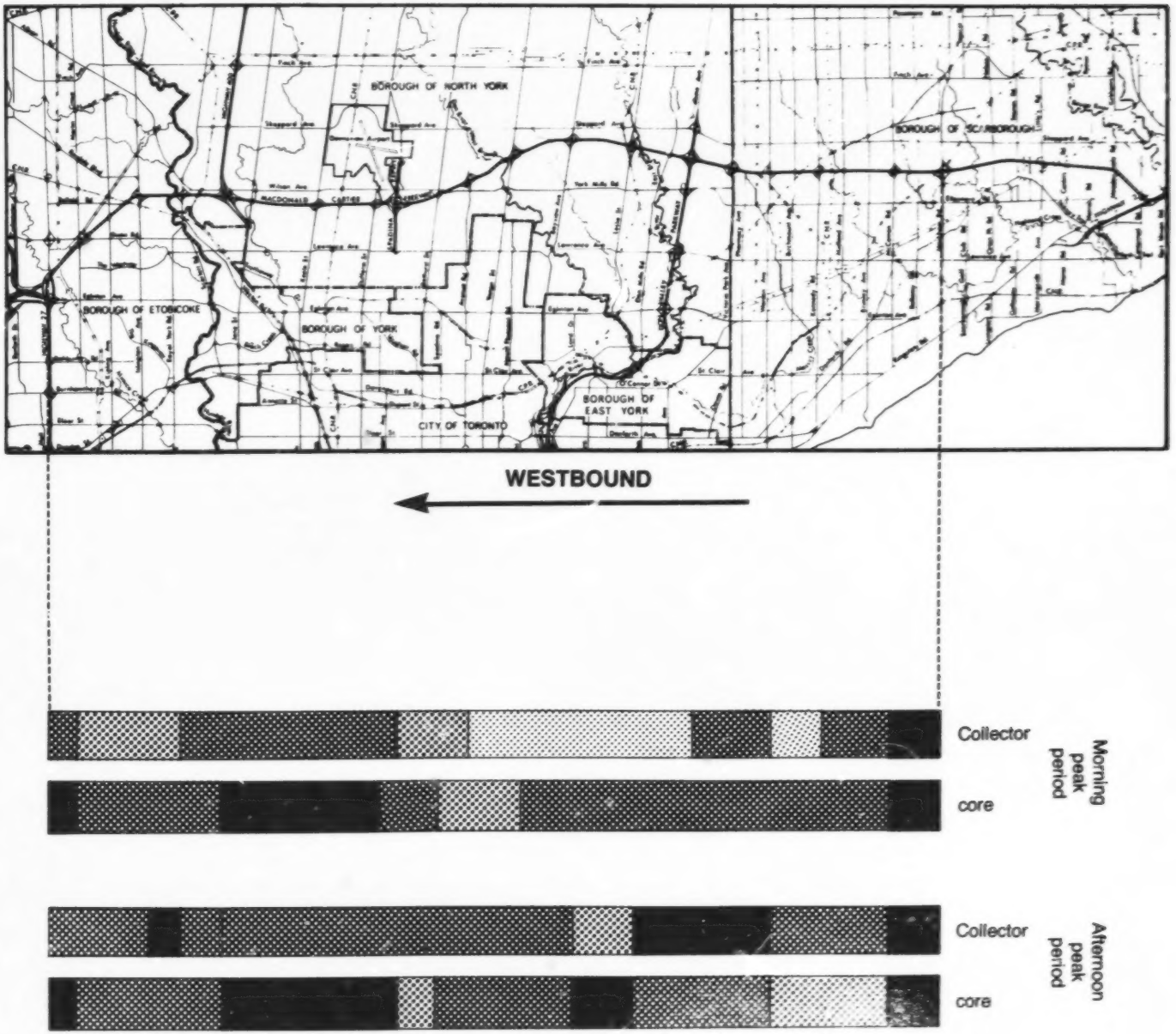


21

Eastbound


BOROUGH OF NORTH YORK
BOROUGH OF SCARBOROUGH
BOROUGH OF ETOBICOKE
BOROUGH OF YORK
CITY OF TORONTO
BOROUGH OF EAST YORK
EASTBOUND
core
Collector
Morning peak period
core
Collector
Afternoon peak period

Westbound


BOROUGH OF NORTH YORK
BOROUGH OF SCARBOROUGH
BOROUGH OF ETOBICOKE
BOROUGH OF YORK
BOROUGH OF EAST YORK
CITY OF TORONTO
WESTBOUND
Collector
core
Morning peak period
Collector
core
Afternoon peak period
50-64 km/h
65-80 km/h
81-100 km/h

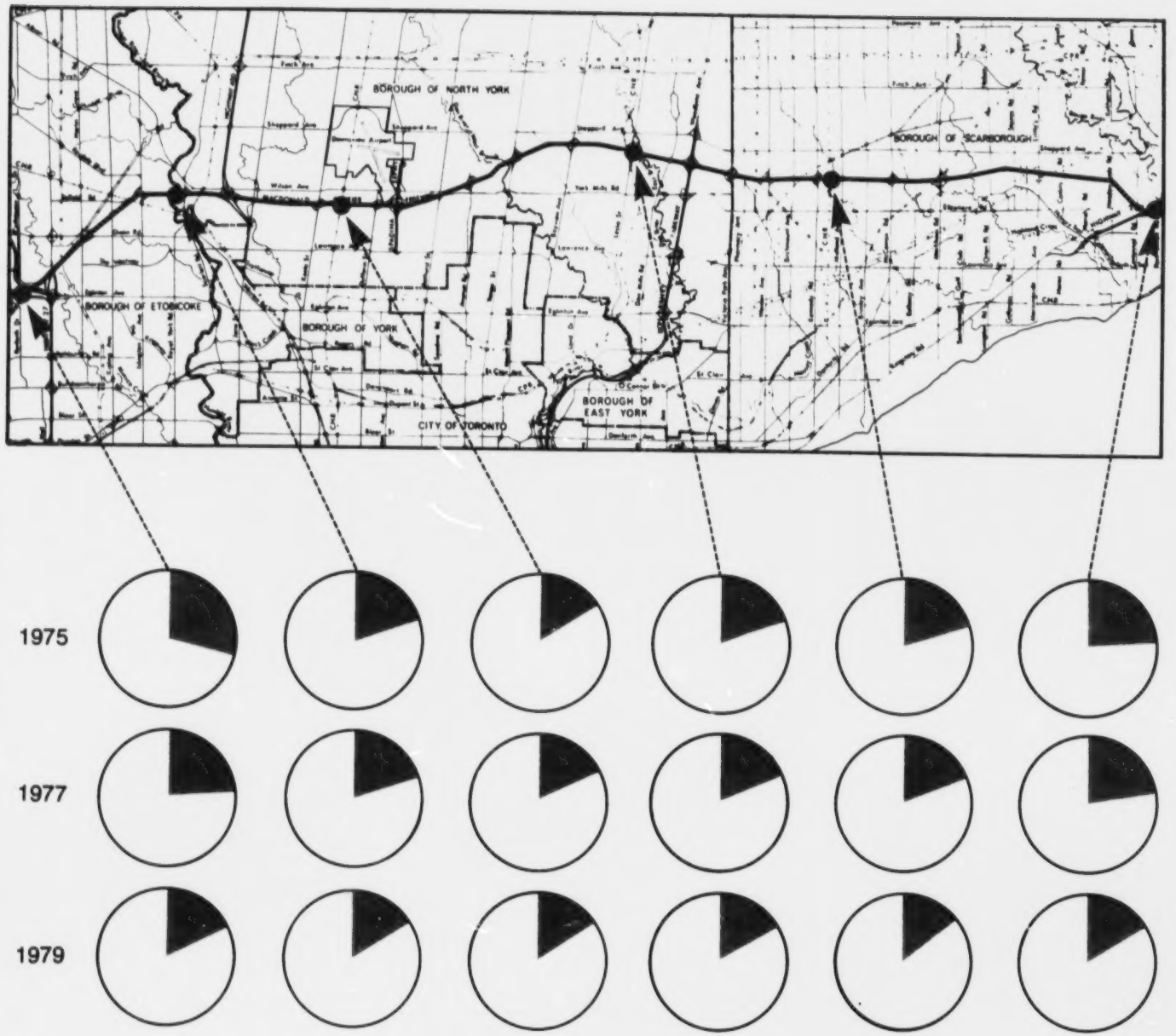
3.4/ Truck Traffic

P.C.S. traffic data do not identify the various types of vehicles passing through the station. Data from the Metropolitan Toronto Cordon Count Program were therefore used to study the traffic characteristics of trucks on Highway 401. Truck traffic data were available for six locations on the highway for three years (1975, 1977 and 1979). Vehicle Classification Counts were for a period of 17 hours (06:30 to 23:30).

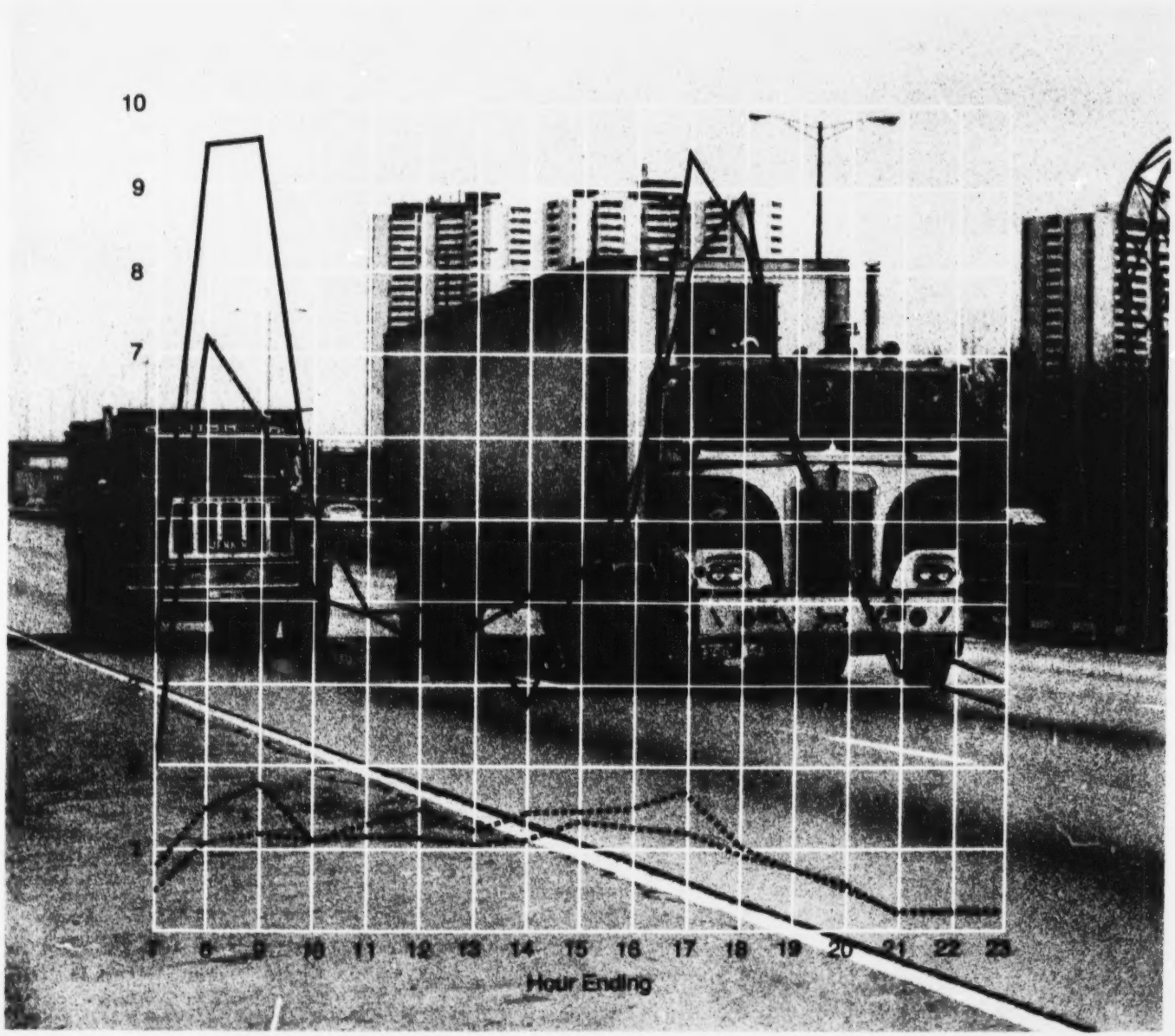
3.4.1/ Traffic Volumes

Stations near the periphery showed a higher percentage truck traffic; however, the number of trucks passing through those stations was less than recorded at the more centrally located stations. The difference was primarily due to the higher volume and greater proportion of auto traffic recorded at the stations closer to the city proper. Between 1975 and 1979, truck traffic decreased gradually as a percentage of total traffic at each location. The decrease between 1975 and 1977 could be attributed to the slower increase of truck traffic as compared to that of auto traffic. However, the changes between 1977 and 1979 resulted from an overall reduction in the number of trucks using the Highway 401. The hourly distribution of truck traffic recorded near the Keele Street intersection showed less variation than the auto traffic. There were no significant peak periods in the morning or in the afternoon. A noticeable decrease of truck traffic in both directions occurred after 17:00.

Truck Percentage
6:30–23:30



East of Keele St. Interchange



Eastbound Westbound

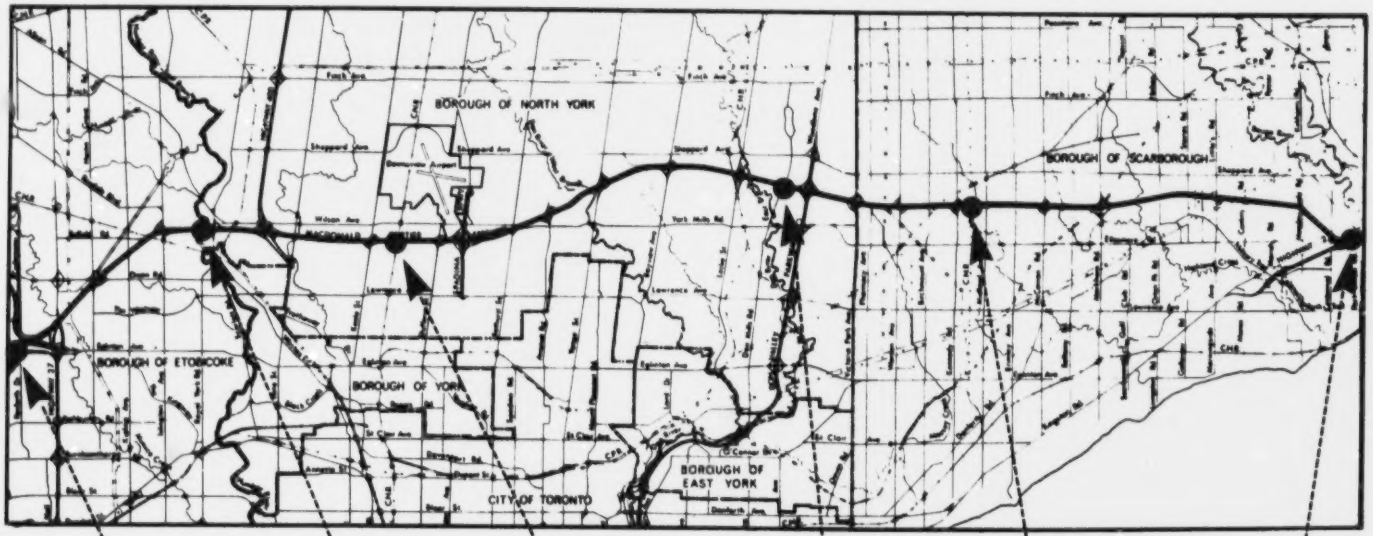
Auto

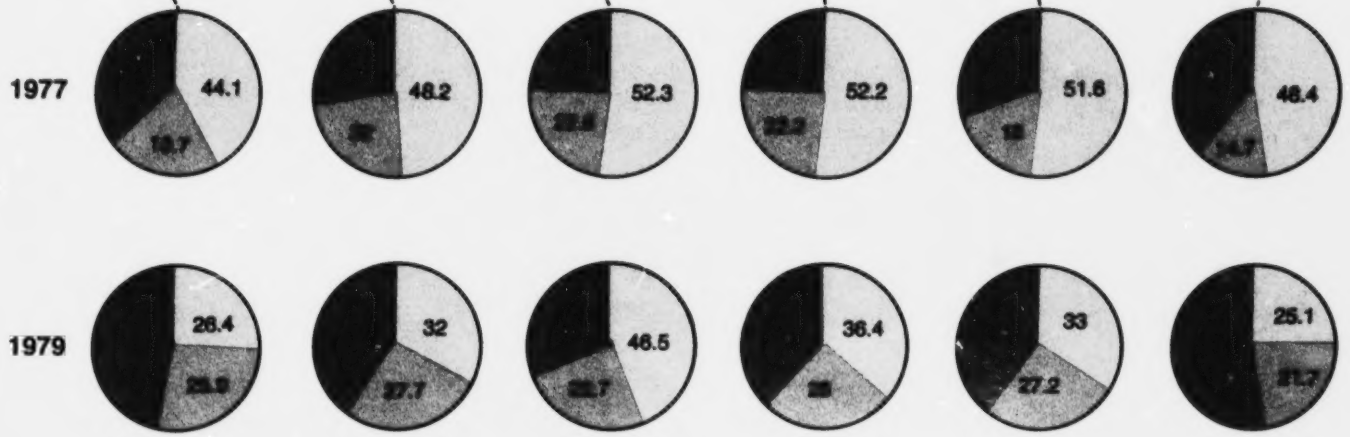
Truck

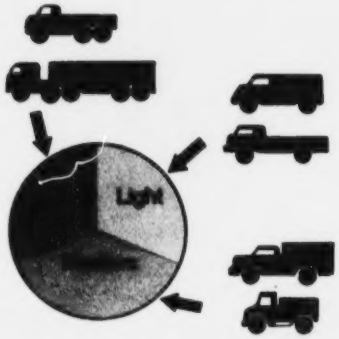
3.4.2/ Types of Trucks

The Metro Toronto Cordon Count Program categorized trucks as light, medium — 2 axles only with dual rear tires, or heavy — more than 2 axles. Between 1977 and 1979, the difference in the percentage distribution of various types of trucks indicated a significant increase in heavy trucks at all stations. In fact, in 1979 at Metro Toronto's east boundary, more than 50% of the trucks counted were heavy trucks. As mentioned previously, during the same time period (1977 to 1979) all the stations observed a decrease in the number of trucks on the highway. The changes in truck traffic composition revealed that the reduction occurred only within the light and medium truck category, while the number of heavy trucks increased significantly.

Truck Distribution Percentage







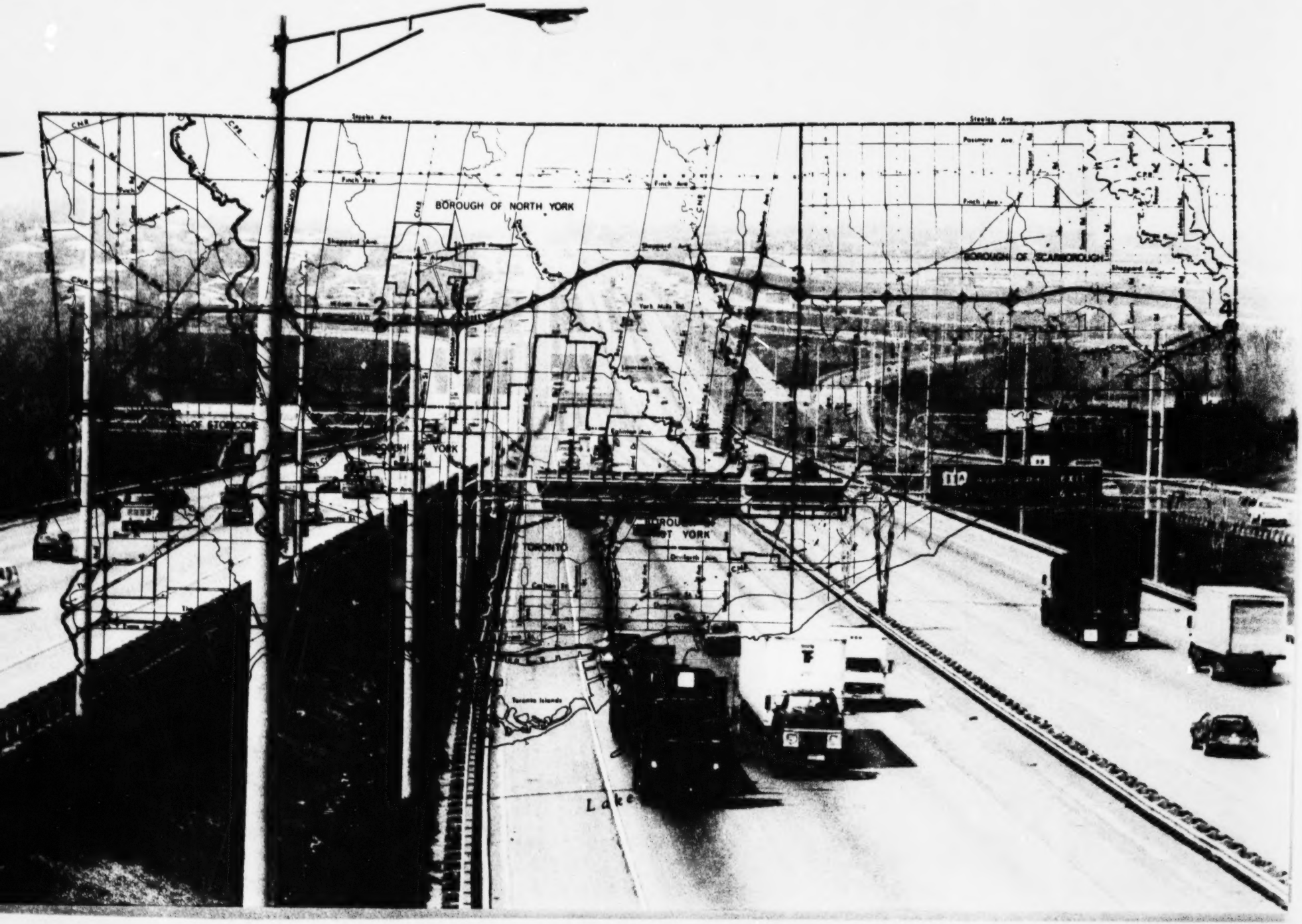
4 Travel Characteristics

4.1/ Origin-Destination Travel Surveys

Travel characteristics of the automobile users of the Highway 401 are based on the information obtained from travel surveys conducted at four locations. Some of the findings may be used to explain the variation of traffic patterns as observed from the data collected at the Keele Street P.C.S.. The surveys were conducted by photographing the front licence plates of automobiles passing through the stations using 35 mm motor driven cameras. The sampling rate was about one in every four passing automobiles. Survey questionnaires were sent to registered owners of the vehicles that were sampled. This technique is a very useful one for obtaining user information on a high speed/high volume highway. However, the sample had to be restricted to auto vehicles registered in Ontario and it excluded leased and company-owned cars.

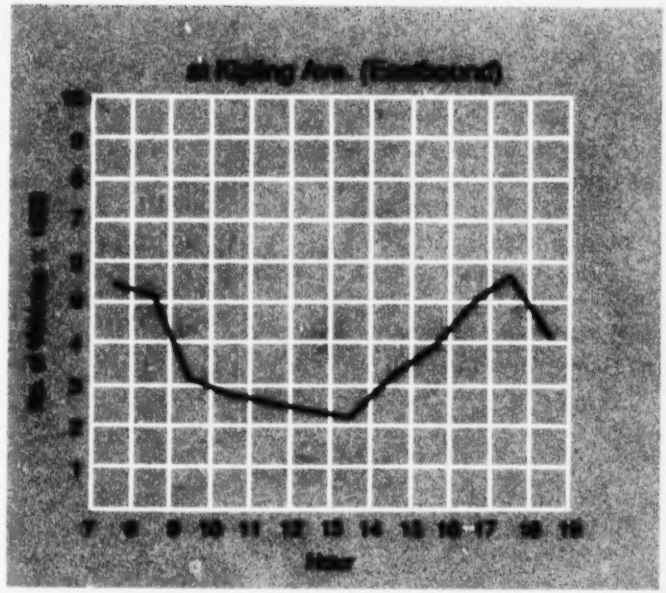
The travel information was obtained at only four points on the highway; however, due to their particular locations and the spacing between the points, the findings should be representative of the other locations on the highway.

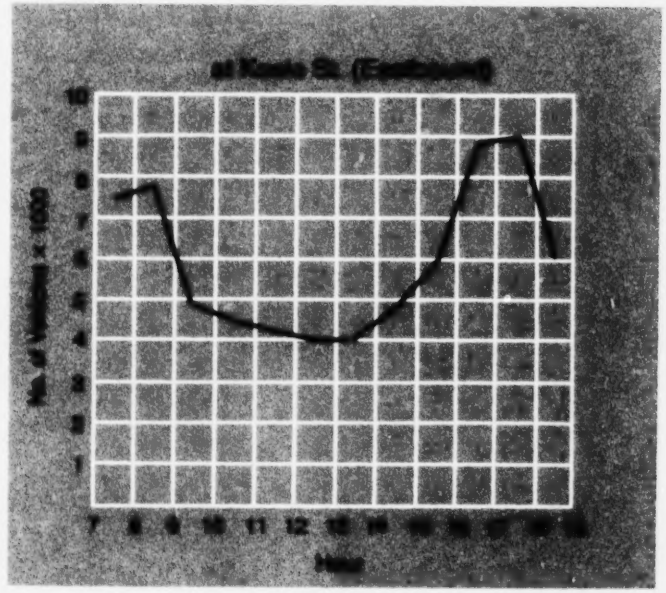
LOCATION	DATE OF SURVEY	DIRECTION
1. at Kipling Ave.	June 7, 1977	Eastbound
2. at Keele St.	May 17–18, 1978	Eastbound
3. at Victoria Park Ave.	May 10, 1978	Westbound
4. at Port Union Rd.	May 7, 1979	Westbound

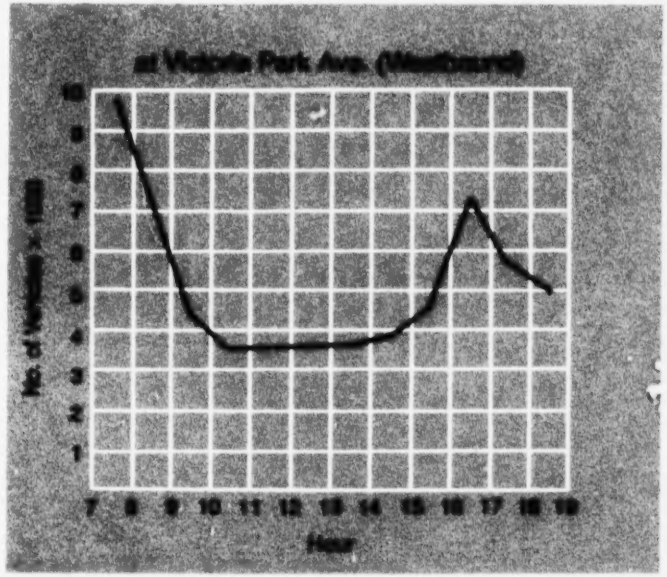

BOROUGH OF NORTH YORK
BOROUGH OF SCARBOROUGH
TORONTO
Lake

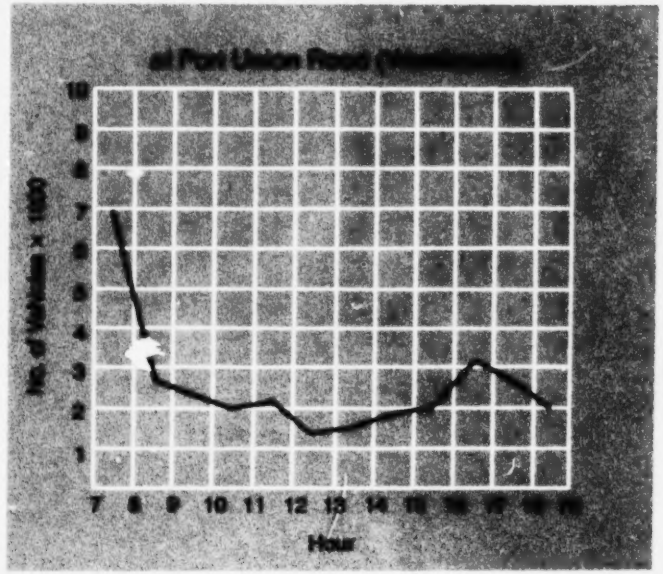
4.2/ Hourly Distribution of Traffic

At each survey station only one direction of traffic was surveyed. As a result only the inbound traffic (towards Yonge Street) was sampled. The four stations recorded a similar hourly distribution pattern of auto traffic over a 12-hour period (07:00 to 19:00) with noticeable peaks in the morning and afternoon. However, for stations located in the west (i.e. at Kipling Avenue and at Keele Street) the primary eastbound peak occurred in the afternoon while those in the east (i.e. at Victoria Park Avenue and at Port Union Road) primary westbound peaks occurred in the morning. For the former, the peaks (primary and secondary) stretched over a two-hour period (07:00 to 09:00 and 16:00 to 18:00) but only lasted for one hour (07:00 to 08:00 and 16:00 to 17:00) at the latter locations.









Auto

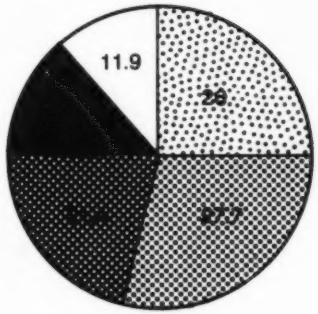
4.3/ Trip Purposes

Between 07:00 and 19:00, more than 50% of the auto traffic recorded at each survey station was related to work purpose (home to work or work to home). The work commuting component became more dominant during the morning and afternoon peak periods. Nearly 90% of the inbound traffic recorded at the Metro east boundary (Port Union Road) fell into that category during the morning peak period. Business-related trips were next significant between 07:00 and 09:00. Throughout the day, business and personal/shopping trips accounted for about 30 to 40% of the total auto traffic recorded.

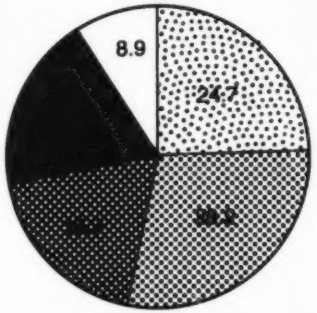
Trip Purposes

7:00–19:00

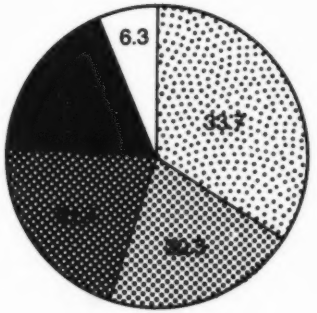
at Kipling Ave.



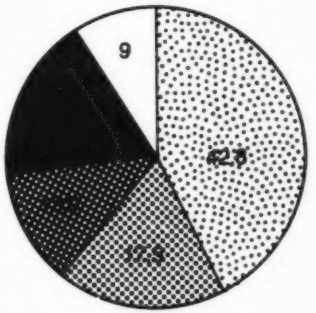
at Keele St.



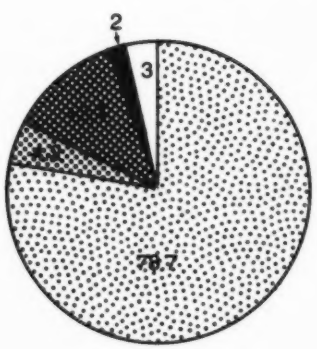
at Victoria Park Ave.

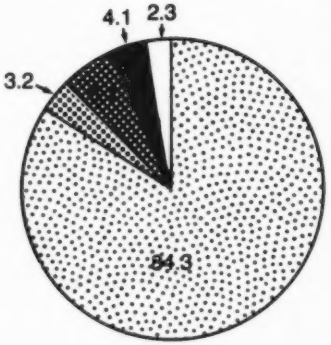


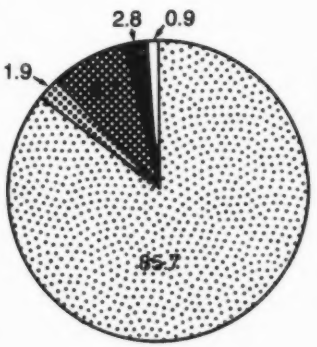
at Port Union Rd.

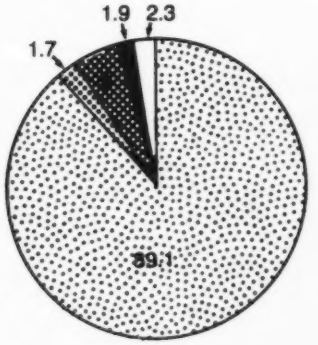


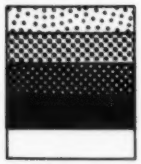
7:00–9:00











Home To Work
Work To Home
Business
Personal & Shopping
Recreation & Others

4.4/ Trip Origins and Destinations

To have a better appreciation of the origin and destination of trips along Highway 401, they were grouped into four major categories:

Category 1 — trips that started and ended within the boundary of Metro Toronto.
Category 2, 3 — trips with either origins or destinations located outside Metro Toronto.
Category 4 — trips originated and destined outside Metro Toronto.

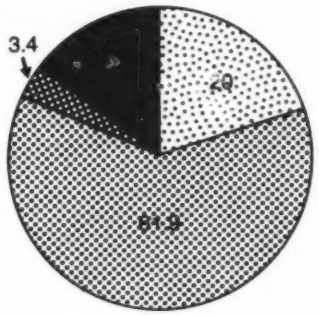
To a certain extent, the distribution of trips among those four categories was closely related to the location where the survey was taken. For example, trips recorded at the Port Union Road station (east boundary of Metro Toronto) could not fall into the first and third categories.

All four stations indicated that more than 85% of the auto traffic had either one trip end (origin or destination) or both in Metro Toronto. More than 50% of the traffic sampled at the Keele Street and Victoria Park Avenue stations started and ended within Metro Toronto. Through traffic constituted only a small portion of total traffic; its share ranged from 6 to 15%. However, if out-of-province vehicles were included, its share of total traffic might change. During the morning peak period (07:00 to 09:00) the percentage of Metro bound traffic increased at all stations due to the great number of commuters entering the city from adjacent municipalities.

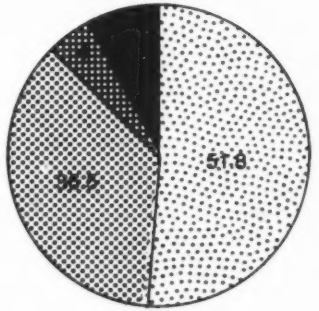
Origin — Destination

7:00–19:00

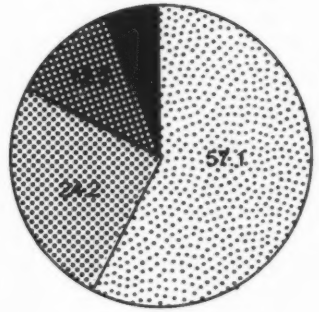
at Kipling Ave.



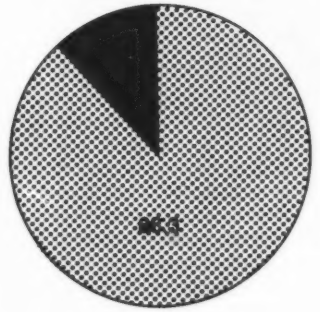
at Keele St.



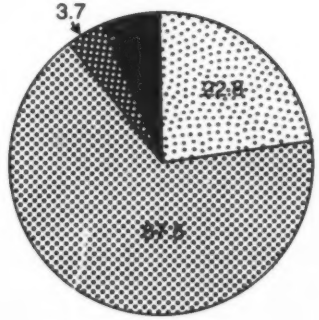
at Victoria Park Ave.

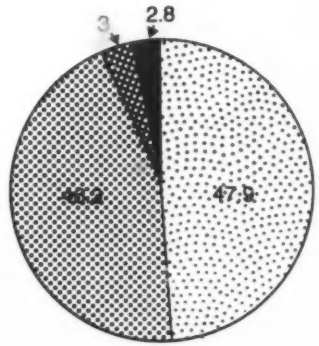


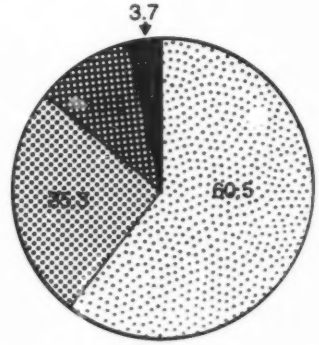
at Port Union Rd.

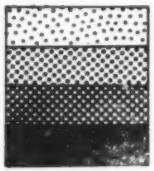


7:00–9:00









Within Metro Toronto

To Metro Toronto
From Other Areas

From Metro Toronto
to Other Areas

Through Traffic

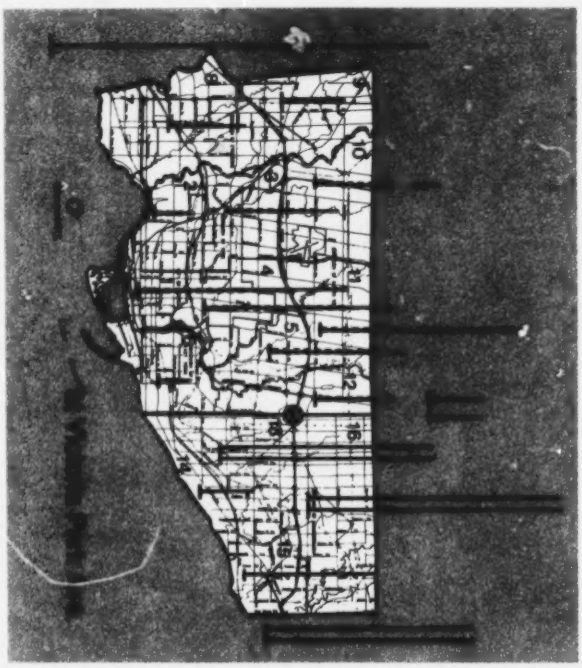
For a closer look at the spatial distribution of trips within Metro Toronto, the origins and destinations were aggregated into 16 planning districts. The resulting distribution patterns vary considerably among those four survey locations. For traffic passing through the Kipling Avenue station, the majority of trips were destined or attracted to districts located immediately along Highway 401. A very small amount of traffic was oriented towards planning district No. 1 (the major activity centre of Metro) because most travellers seeking that destination used the more direct alternative routes of Highway 427 and the Gardiner Expressway. As observed previously, only 20% of the traffic had both origins and destinations located within Metro Toronto. Towards the city proper, trip ends were more widely distributed as illustrated by the Keele Street station. A similar distribution pattern was observed at the other two stations in the east. A considerable volume of traffic to planning district No. 1 was recorded at the Victoria Park Avenue station since the combination of Highway 401 and Don Valley Parkway provides a faster route for trips from the east to the central business district. The portions of trips destined to each planning district which originated within Metro Toronto were also indicated.

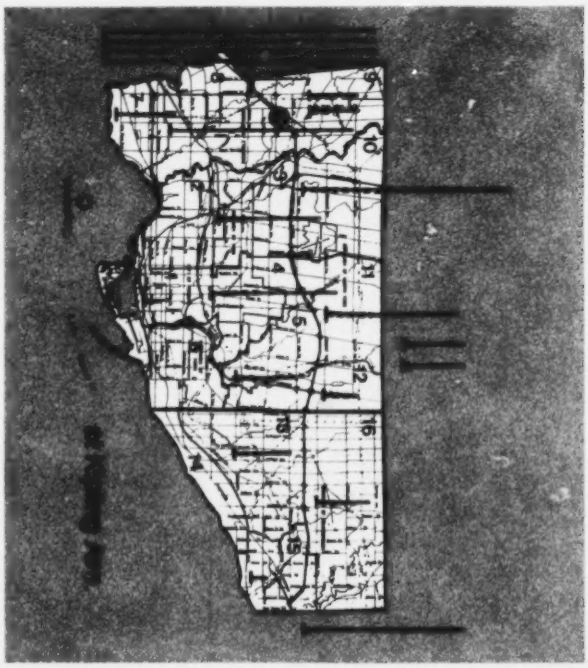
2000 Trips

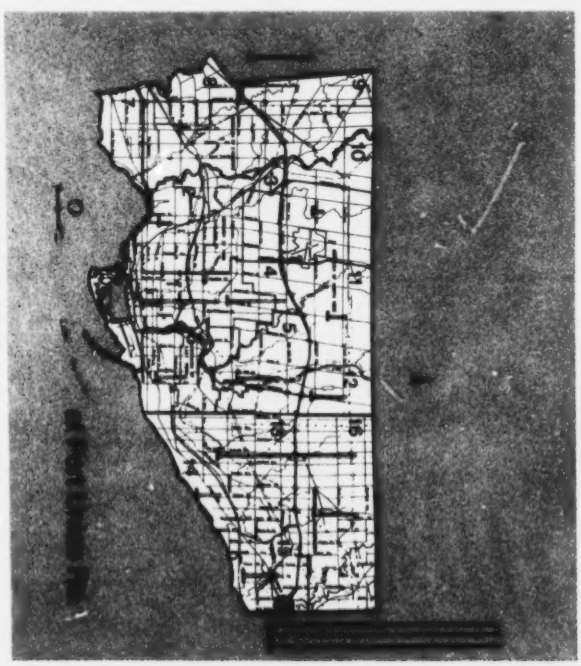
Trips Originated

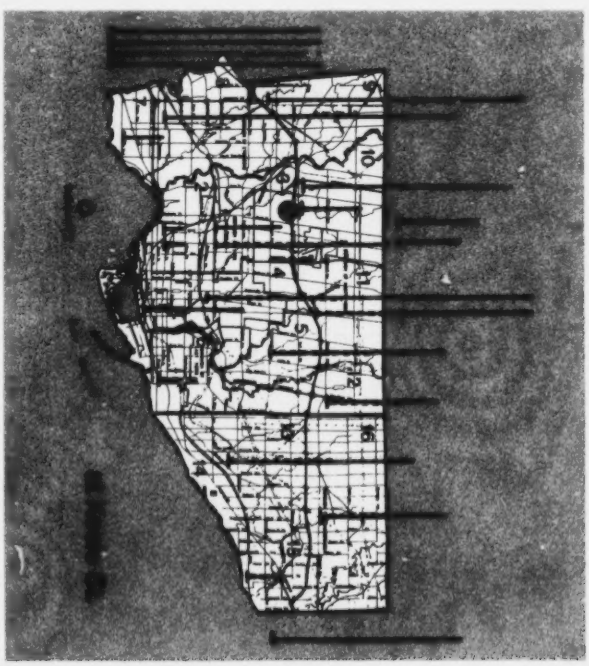
Trips Destined

Trips Originated in Metro









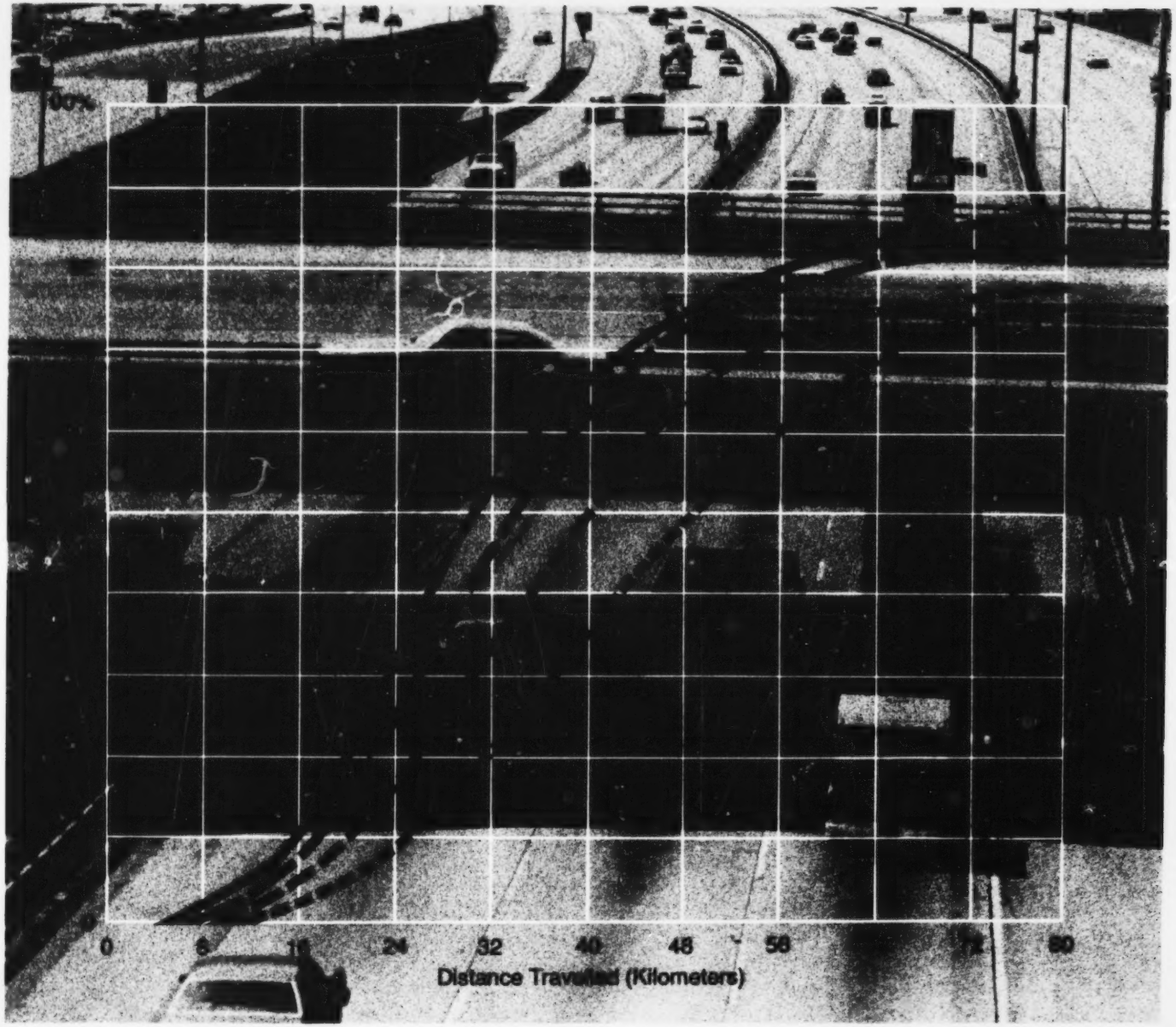
4.5/ Trip Length

The following table summarizes the average distance travelled for work and non-work purposes as recorded at the four stations.

STATION	NON-WORK		WORK		ALL PURPOSES	
	km	*miles*	*km*	*miles*	*km*	*miles*
Kipling Ave.	93.3	58	41.8	26	77.2	48
Keele Street	59.5	37	37	23	54.4	34
Victoria Park Ave.	70.7	44	33.7	21	53.1	33
Port Union Rd.	94.9	59	48.2	30	67.5	42

The average distance travelled was calculated from trip origin to trip destination and included that portion travelled on the Highway 401. Trips sampled at the two more centrally located stations (Keele Street and Victoria Park Avenue) had shorter average trip lengths than those recorded at the other two stations. About 50% of the trips sampled at Victoria Park Avenue station travelled less than 32 km (20 miles), while half of those surveyed at the Port Union Road station travelled more than 48 km (30 miles). The difference was probably due to the larger proportion of trips travelled solely within Metro Toronto which usually covered shorter distances as recorded by the former two stations. The average distance travelled for trips within Metro Toronto was about 25.6 km (16 miles) and only about 10% of those were less than 16 km (10 miles).

In terms of distance travelled by major trip purposes, the average trip length for work trips was about half of that for non-work purposes, which included recreational and tourism trips that covered very long distances. The variation in the average distances travelled to and from work recorded at all four stations was much less than that for non-work trips.


100%
0
8
16
24
32
40
48
56
72
80
Distance Travelled (Kilometers)
Station at
Victoria Park Ave.
Keele St.
Kipling Ave.
Port Union Rd.

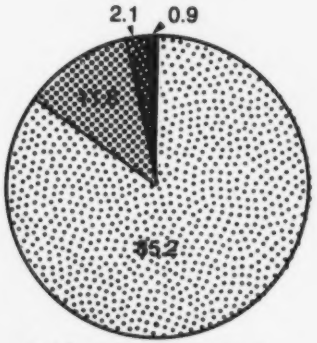
4.6/ Vehicle Occupancy Rate

There is very little variation in the average vehicle occupancy rate as recorded by all four stations. For all trip purposes, the Port Union Road station recorded the highest average — 1.43 persons/vehicle — while the lowest was obtained from the Victoria Park Avenue station — 1.32 persons/vehicle. With the exception of the station at Port Union Road, more than 80% of the vehicles used for work and business related purposes had only one occupant (driver). For non-work trips, about 50% of the vehicles were occupied by two or more persons, and more than 15% had three occupants. Port Union Road station recorded the highest occupancy rate — 1.26 persons/vehicle for work and business trips. For non-work purposes, there were more vehicles with two persons than those with only one occupant.

Vehicle Occupancy Rate

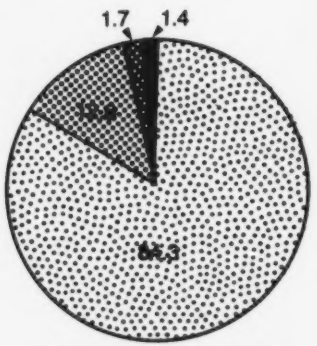
Work + Business

at Kipling Ave.



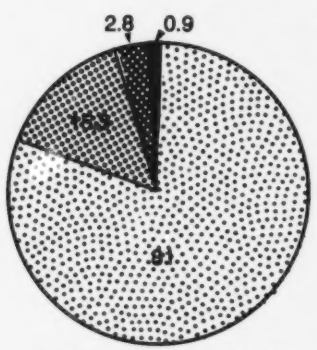
1.18 persons/vehicle

at Keele St.



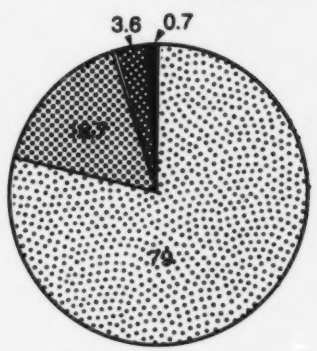
1.21 persons/vehicle

at. Victoria Park Ave.



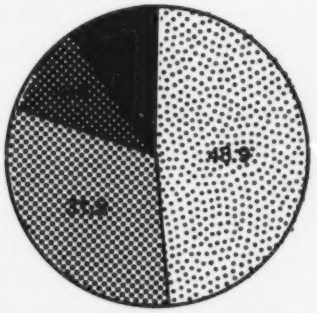
1.22 persons/vehicle

at Port Union Rd.

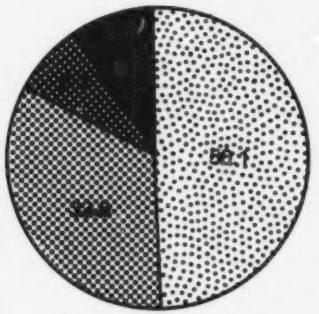


1.26 persons/vehicle

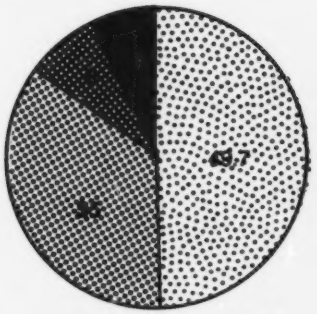
Non Work



1.85 persons/vehicle

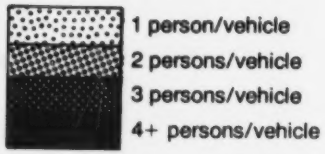


1.77 persons/vehicle



1.74 persons/vehicle

1.9 persons/vehicle

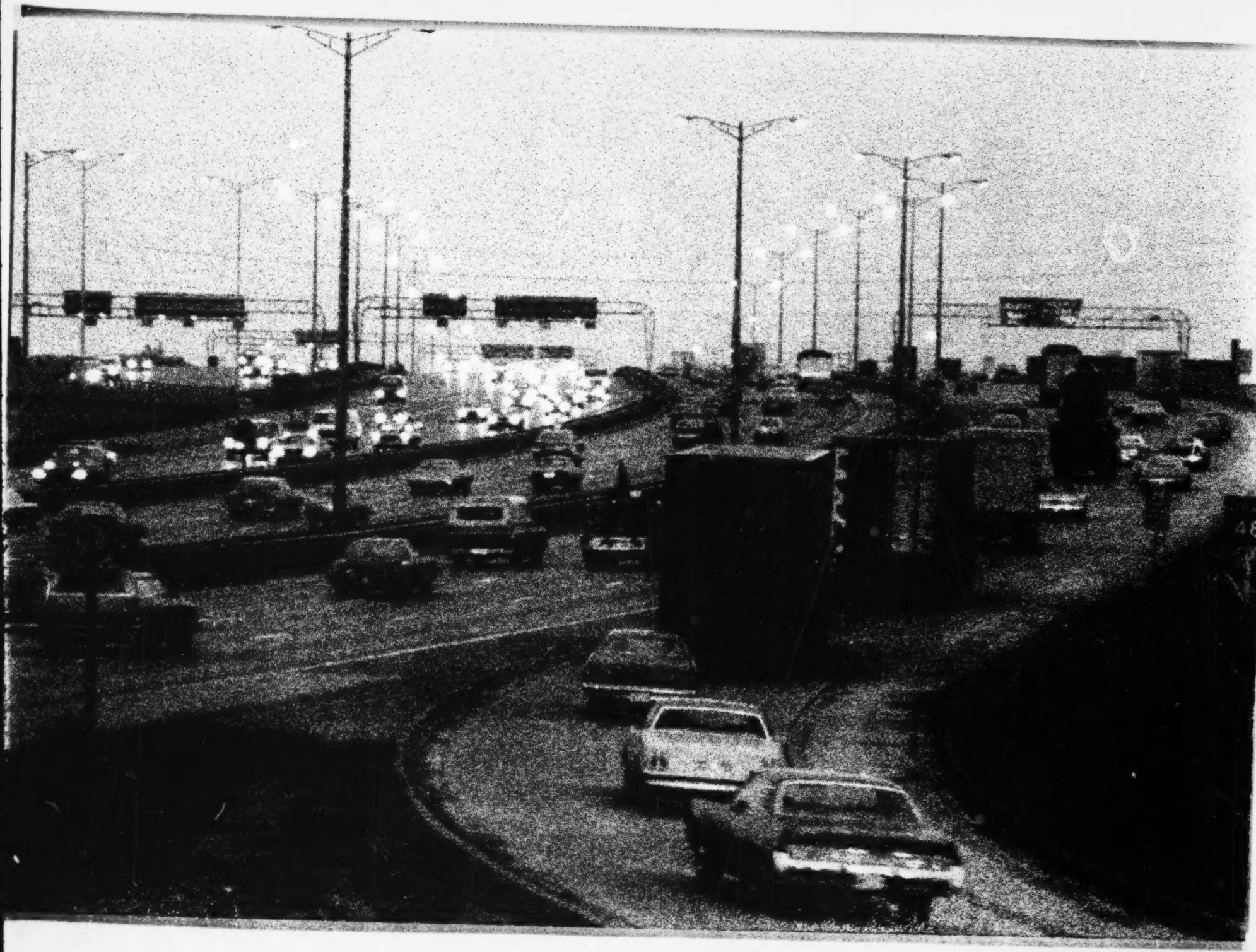


5 Concluding Remarks

Through the brief discussion of the data collected from the traffic counting activities and travel surveys, a number of noticeable user characteristics have been identified. It is apparent that the stretch of the MacDonald-Cartier Freeway in Metro Toronto functions primarily as a major urban expressway and serves a secondary function as the Toronto Bypass. The majority of traffic it carries is related to work-commuting and business purposes. They dominated the traffic volume in two 2 to 3 hour periods of the morning and afternoon; most of the work trips travelled an average distance of 32 km (20 miles). The average car occupancy rate was about 1.3 persons per vehicle.

The data also reveal several areas of concern. Due to the heavy volume of traffic during the peak periods, the speeds on various sections of the highway were greatly affected. With various sections of the highway having different operating speeds, it not only reduces the overall operating efficiency of the facility but also poses safety considerations. Another concern comes from the significant increase of heavy trucks mixing with an increasing number of smaller passenger cars in the traffic streams. Since 80% of the commuters on the highway drive alone, there is considerable room for car/van pooling to reduce the growing demand for capacity during the peak periods of the day.

Recently, the Ministry of Transportation and Communications completed a Highway 401 Corridor Traffic Systems Management Study in order to address some of those major concerns. Various measures including a traffic surveillance system will be implemented to maintain the quality of service of the highway for the efficient movement of people and goods.



6 Look to the Future

Although Highway 401 has not experienced the severe congestion problems of other highways, there has been a continuous deterioration of traffic conditions on the 401 Toronto Bypass in the last 20 years.

The annual average daily volume has continually exceeded predictions and is increasing at a rate of 2 to 6% per year.

And, because chronic congestion in the Highway 401 corridor as a whole may soon become a reality unless remedial action is taken, the Ministry of Transportation and Communications is looking at ways to alleviate this traffic problem.

The new Metro Toronto Traffic Control Centre, located within the corridor at Yonge Street and Sheppard Avenue, could provide the desired integrated control of the freeway and neighbouring urban street network.

It is anticipated that loop detectors, closed-circuit television cameras and monitors, and a central traffic-control computer will be featured in this highway traffic management system.

As well, widespread practice of variable work hours and increased car occupancy (vanpools/carpools) will serve to lower the congestion problem.

Looking to the future, we will see that Highway 401 will experience a decentralization effect as more vehicles interact between centres located away from the Central Business District.

The commuter-shed in Toronto will mature, and there will be no significant increase in long-distance commuting traffic. A proposed rapid transit line in the corridor will serve short distance commuters.

Possible long-term relief may be found with the completion of Highway 407, north of Toronto.